Technical Report 893

Design of a Threat-Based Gunnery Performance Test: Issues and Procedures for Crew and Platoon Tank Gunnery

R. Gene Hoffman, Carolyn Hill Fotouhi, Glen A. Meade,
and H. Ric Blacksten
Human Resources Research Organization

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Threat-based tank gunnery performance testing procedures were developed using a seven-step process that included (a) describing the tank gunnery domain, (b) determining general test requirements, (c) analyzing gunnery outcome (speed and accuracy) measures and developing a recommended approach, (d) analyzing gunnery process measures (e.g., target acquisition, fire commands) and developing a recommended approach, (e) setting standards, (f) analyzing devices and making recommendations, and (g) developing test administration procedures. The test comprises (a) crew and platoon skill echelons, (b) Combat Tank Tables and threat-based target arrays, and (c) live fire and instrumented dry fire. After reviewing several alternatives, the hit expectation ratio metric that underlies Tank Table VIII was identified as the most conceptually complete outcome metric available. A spreadsheet format was prepared for extending the calculation of hit expectation ratio for crew gunnery for three, four, and five threat targets in an array. The mathematics of a suggested solution for calculating a platoon gunnery hit expectation ratio were presented. To support assessment (Continued)

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of the behaviors and activities of crew and platoon gunnery, a series of descriptive rating scales were developed.

A content evaluation of live fire and dry fire instrumentation systems was conducted to make recommendations for each of the eight components of the gunnery test. Live Fire Tables VIII and XII were included in the gunnery test without modification. This segment of the criterion test anchors the test by (a) providing familiar information that is readily accepted, and (b) allowing for the comparison of results with previous research findings. The remaining portions of the test extend data collection to additional types of engagements and to gunnery skills that are not well-suited to live fire safety constraints. Tank Weapon Gunnery Simulation System (TWGSS) was identified as the preferred dry fire instrument; however, it is not yet available. As an alternative, Precision Range Integrated Maneuver Exercise (PRIME) was recommended to support measurement of the aspects of gunnery that are not well-suited to live fire.

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Design of a Threat-Based Gunnery Performance Test: Issues and Procedures for Crew and Platoon Tank Gunnery

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Human Performance Effectiveness and Simulation

FOREWORD

In a time of decreasing budgets and increasing training costs, the Army is considering simulation a cost-effective alternative to field training. The issue is a complex one involving trade-offs between training alternatives and level of readiness. Empirical solutions regarding these trade-offs will only come from well-constructed research designs supported by valid and reliable manipulations and measures. Tank gunnery is the *sine qua non* of armor readiness and therefore the preeminent criterion of much of armor training. The subject of this report is the measurement of tank gunnery proficiency. It describes the issues and recommends actions for the researcher embarking on trade-off research in tank gunnery. The methodologies developed will facilitate the systematic, efficient, and realistic testing of tank gunnery at the crew and platoon levels. The methods represent an important contribution to the Army Research Institute for the Behavioral and Social Sciences' (ARI's) 6.2 Exploratory Development program and will facilitate the execution of well-directed trade-off research in gunnery training.

This research is a part of the ARI task entitled "Application of Technology to Meet Armor Skills Training Needs." It is performed under the auspices of ARI's Armor Research and Development Activity at Fort Knox. The proponent for the research is the Deputy Chief of Staff, Training, Training and Doctrine Command (TRADOC). The requirement for this research has also been recognized by the Office, Secretary of Defense.

Edgar M. Johnson

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Technical Director

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DESIGN OF A THREAT-BASED GUNNERY PERFORMANCE TEST: ISSUES AND PROCEDURES FOR CREW AND PLATOON TANK GUNNERY

EXECUTIVE SUMMARY

Requirement:

In order for empirical research to successfully compare training alternatives in tank gunnery, researchers must (a) understand the nature of the criterion they are using as a dependent variable and (b) have appropriate methods and instruments for assessing gunnery proficiency. The purpose of this report is to fulfill both of those needs. It is part of a series of reports that provide technical assistance and research tools for examining trade-off issues in gunnery training.

Procedure:

The design of a threat-based gunnery performance test followed a seven-step process that included:

- describing the gunnery domain,
- determining general test requirements,
- analyzing gunnery outcome (speed and accuracy) measures and developing a recommended approach,
- analyzing gunnery process (e.g., target acquisition, fire commands) measures and developing a recommended approach,
- setting standards, if appropriate,
- analyzing devices and making recommendations, and
- developing test administration procedures.

Findings:

The tank gunnery domain definitions at the crew and platoon levels (provided by a previous report in this series [Morrison, Meade, & Campbell, 1990]) and a discussion of the deficiencies of Tank Table VIII for training research lead to a recommendation for a comprehensive gunnery criterion test. The test comprises three parameters each with two levels of conditions for a total of eight (2^3) separate components. These components represent all of the combinations of skill echelon (crew or platoon), target base (Combat Tables or threat arrays), and firing mode (live fire or instrumented dry fire). The skills that can be tested within each component will vary as a direct function of the three parameters. For any one component and for the

test as a whole, outcome measures that summarize speed and accuracy of firing and process measures that assess the various behaviors and actions required for proficiency are appropriate.

Quantifying gunnery speed and accuracy is complex. After reviewing several alternatives, the hit expectation ratio metric that underlies Table VIII was identified as the most conceptually complete metric available. Hit expectation ratio includes speed and accuracy of hits, and it incorporates the aspect of survival associated with hitting targets in order of their threat magnitude. A spreadsheet format was prepared for extending the calculation of hit expectation ratio for crew gunnery for three, four, and five threat targets in an array. The mathematics of a suggested solution for calculating a platoon gunnery hit expectation ratio were also presented.

To support assessment of the behaviors and activities of crew and platoon gunnery, a series of descriptive rating scales were developed. These include eight rating scales for crew performance, eight rating scales for platoon performance, and six rating scales for platoon leader and platoon sergeant performance.

<u>Crew Categories</u>

- Search Procedure
- Acquisition Reports
- Normal Mode Fire Commands and Reengagement
- Degraded Mode and Subsequent Fire Commands
- Movement
- Reaction Drills
- Contact Reports
- Spot Reports

<u>Platoon Categories</u>

- Route Selection
- Movement
- Position Selection
- Intra-Position Movement
- Orientation (Defense)
- Orientation (Offense)
- Direct Fires
- Communication

<u>Platoon Leader/Platoon Sergeant Categories</u>

- Fire Planning
- Fire Commands
- Request Indirect Fires
- Operations Orders
- Fragmentary Orders
- Supervision

Workshop materials were prepared for training crew and platoon evaluators to use the rating scales along with workshop materials for setting performance standards on the scales.

A content evaluation of live fire and dry fire instrumentation systems was conducted in order to make recommendations for each of the eight components of the gunnery test. Live Fire Tables VIII and XII were included in the gunnery test without modification. This segment of the criterion test anchors the test by (a) providing familiar information that is readily accepted and (b) allowing for the comparison of results with previous research findings. The remaining portions of the test extend data collection to additional types of engagements and to gunnery skills that are not well-suited to live-fire safety constraints. Tank Weapon Gunnery Simulation System (TWGSS) was identified as the preferred dry fire instrument; however, it is not yet available. As an alternative, Precision Range Integrated Maneuver Exercise (PRIME) was recommended to support measurement of the aspects of gunnery that are not well-suited to live-fire.

Finally, sample test plans for a test application at the Phantom Run range facility at Ft. Hood, TX, were developed. Complete documents and details needed to actually execute a gunnery exercise following standard Army protocol were produced.

Utilization of Findings:

The purpose of this report is to serve the Army research community in the design and conduct of gunnery training research. A number of useful concepts and directly usable products were prepared. In addition, several of these products may be of use to the Armor community. For example, the Armor community is currently analyzing approaches to scoring single tank gunnery when more than two threat targets are presented. The scoring discussion and spreadsheet presented should provide valuable assistance.

DESIGN OF A THREAT-BASED GUNNERY PERFORMANCE TEST: ISSUES AND PROCEDURES FOR CREW AND PLATOON TANK GUNNERY

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DESIGN OF A THREAT-BASED GUNNERY PERFORMANCE TEST: ISSUES AND PROCEDURES FOR CREW AND PLATOON TANK GUNNERY

Chapter 1. Introduction

This report is one of a series of reports that focuses on the development of research tools for empirically investigating alternative crew and platoon tank gunnery training devices and strategies. These tools have included methods for determining threat engagements for tank gunnery (Campbell & Campbell, 1990; Doyle, 1990) and methods for matching threat engagements to crew and platoon task and skill requirements (Campbell & Hoffman, 1990). These methods were designed to provide background information for additional analysis of gunnery training requirements. Additional research tools in this series include methods for organizing tasks and subtasks to facilitate learning analyses (Morrison, Meade, & Campbell, 1990) and methods for designing prototypic training strategies (Morrison & Holding, in preparation). These prototypic strategies can then be submitted to empirical examination of learning and transfer of training. To do so requires one final tool, a comprehensive assessment of tank gunnery performance to use for criterion measurement. This is the subject of the current report.

Statement of the Problem

Over the last decade, there has been a substantial amount of research addressing problems in tank gunnery training. Much of that research has relied on tank live-fire engagements as defined by Tank Table VII or VIII performance as the dependent variable or criterion measure (Biers & Sauer, 1982; Black & Mitchell, 1986; Eaton, 1978; Hoffman & Melching, 1982; Hughes, Butler, Sterling, & Berglund, 1987; Martellaro, Thorne, Bryant, & Pierce, 1985; Powers, McCluskey, Haggard, Boycan, & Steinheiser, 1975; Rapkoch & Robinson, 1986; Scribner, Smith, Baldwin, & Phillips, 1984). Much of that research has failed to statistically support hypothesized relationships. A few of those studies (e.g.,Hoffman & Melching; Powers et al.) have found that a potential problem was the unreliability of performance in the live-fire criterion test. Some of those problems have been attributed to the difficulty of obtaining reliable performance data (Powers et al.; Martello et al.). Hoffman (1989) conducted an examination of Table VIII scores from the instrumented Table VIII range at Grafenwoehr, FRG. Results of that analysis called into question the use of Table VIII for research purposes, at least as it is currently administered and scored. One such problem is a restriction in the range of the scores created by an artificial scoring ceiling and very few scores below the 700 point passing mark. In addition, there appears to be a tendency to allow refiring opportunities without making available first run scores.

There are several issues related to the use of Table VIII as a criterion measure for conducting research. First, operational use of a performance assessment instrument tends to thwart research use. Second, performance measurement in tank live fire gunnery is technically difficult. Third, gunnery performance may be inherently unstable because it includes a large psychomotor skill component. Finally, the content of Table VIII fails to consider explicitly the fidelity of the target arrays as representative of the threat. Much less research has been conducted at the platoon level, and

consequently Table XII live fire exercises for the platoon have received little scrutiny. However, the same flaws would be expected in Table XII.

The first issue related to use of Table VIII may be stated as follows: Because various administrative decisions are made from operational use of performance assessments, there is a well-known tendency for scores to be inflated in various ways (Wherry, 1952). A manifestation of this principle is that during typical training in gunnery, units attempt to reduce any element of surprise in Table VIII engagements by surreptitiously determining target locations prior to running the course (a process known as "G-2ing" the course). This severely reduces, if not eliminates, the target acquisition aspects of gunnery and narrows the performance distribution. When such "G-2ing" is known to have been controlled, the Table VIII performance distribution is wider and mean scores lower (D. A. Campshure, personal communication, November, 1989) than expected from other studies (e.g., Hoffman, 1989; Hughes et al., 1987). Other subtle influences can intrude on scoring such as timing of target appearance or interpretation of criteria for determining equipment alibis which legitimately allow refiring to be credited as first run scores rather than second run. Thus, when research is conducted as an adjunct to on-going training, Table VIII scores may not be as representative of true gunnery performance as desired.

Second, assessing target hits, the primary outcome of gunnery performance, is technically difficult and is contaminated by ammunition errors. In some of the older studies (e.g., Powers et al., 1975; Hoffman & Melching, 1982), target hits were assessed by visual detection. Detecting hits on a target a mile away made by an object approximately 1 1/2 inches wide traveling at approximately 2880 miles per hour is difficult. It should not be surprising that independent judges have been found to have low agreement (Eaton, 1978). Obtaining reliable judgments is difficult even when rounds are photographed or videotaped and the replays judged. More recently, automated target sensors have been used to assess vibrations on targets. These sensors then activate target devices, lowering targets that are hit. These sensors are not perfect but are subject to errors that can cause targets to go down prematurely or to stay up when hit. Visual assessment, as unreliable as it is, is therefore used as a backup judgment of target hits. Finally, the training rounds themselves are sufficiently unstable that a perfectly aimed training round has a great enough probability of missing the target (dispersion) to noticeably affect reliability.

An often overlooked characteristic of scoring is that target hits are counted as equivalent to target kills. This represents a deficiency in scoring (i.e., leads to less information) that can also result in inappropriate responding (incomplete target assessment). Realistically, target hits will not always result in target kills. Ammunition, range, aspect angle, and location of hit all influence the result of a hit. To the extent the tank crew can control these factors, equating hits to kills ignores these aspects of gunnery. However, typical panel targets cannot provide sufficient information to allow immediate assessment of kills rather than hits.

Third, gunnery performance contains a psychomotor skill component. While the effect may not be strong with stationary or slow moving targets, psychomotor skills tend to be inherently unstable as exhibited by low trial to trial correlations for performance (Ackerman, 1988). Thus, apart from

measurement errors *per se*, performance itself may inflict some degree of unreliability in gunnery scores.

Fourth, Table VIII is criticized as failing to explicitly consider threat doctrine and array expectations in target specifications. Although FM 17-12-1 purports to base Tank Tables on "threat doctrine in the employment of their weapon systems" (p. 11-3), the target arrays specified have at least two noticeable differences from the threat analyses conducted by Laferriere, Chiefo, and Watson (1987) and by Doyle (1990). First, in essentially all engagements identified by Doyle and in over 75% of the engagements identified by Laferriere et al. target arrays are a mix of tanks and BMPs. The combination of tanks and BMPs occurs in none of the Table VIII engagements, nor in any of the platoon Table XII engagements. The significance of this lies in the potential confusion over engagement selection (e.g., multiple versus simultaneous), ammunition selection, loading, assessment of target effects, and fire adjustment. In addition to target mixes, the number of targets in the Tank Table engagements do not appear consistent with the Laferriere et al. and Doyle analyses. Particularly when Blue (threat jargon for M1 or other U.S. Army forces) is in the defense, threat analysis target arrays are larger than the two or fewer targets per tank found on Tables VIII and XII. Thus, in terms of both number and mix, the current Tank Tables do not sufficiently cover the domain of engagements that are likely to be faced in combat.

Finally, Table VIII has been criticized as too narrow. That is, Table VIII assesses only the marksmanship aspect of gunnery and fails to integrate any concern for the required coordination among tanks (Hoffman & Morrison, 1988). A complete evaluation of gunnery needs to include assessment of those crew behaviors required for coordination (e.g., reporting, searching in section, firing in response to platoon fire command) plus the platoon level skills that enable four tanks to act as a synchronized unit.

For the above reasons, Tank Combat Table VIII is viewed as a deficient source of information for conducting research on tank gunnery training. This should not be construed to mean that the information from Table VIII is incorrect, but rather that it is incomplete. Conceptually the basic solution is straightforward. More observations of gunnery performance under a wider variety of conditions are needed. This should increase both the reliability and content validity of the measure. In addition, consideration needs to be given to supplementing measures of gunnery outcomes (times and hits) with measures of the major skill components of gunnery proficiency. That is, there are a variety of skills integrated in tank gunnery proficiency and research needs to be able to address training issues at the skill level as well as overall proficiency. Too often in past research, the manipulation of training has been defined only in gross terms of hours of training on particular devices with the criterion being overall performance. Few successful attempts have been made to segment conclusions by systematically looking for training effects at the component skill level.

Definition of the Gunnery Domain

A significant problem in the testing of gunnery has to do with the complexity of the gunnery domain. Gunnery in its most basic form is a crew level function, but survival in battle depends on the integration of crew actions into a coordinated platoon effort. In the battle context, tactical

gunnery, as opposed to pure shooting or marksmanship, is a platoon level activity. Therefore, a comprehensive measure of tank gunnery needs to include both individual tank marksmanship and platoon level coordination.

Morrison et al. (1990) have provided a gunnery task organization that includes both crew and platoon level activities. In addition, the crew and platoon activities are tied to threat conditions as defined earlier in the project by Doyle (1990). The domain, including activities and threat engagements, provides a structure from which to select performance variables and organize performance assessments. The organization of the domain strives to provide a few basic categories, or skills, of gunnery performance at both the crew and platoon level. The goal was to go beyond an abstract, single "gunnery proficiency" construct (e.g., such as a Table VIII or Table XII score) by differentiating major aspects of the gunnery domain. On the other hand, the kind of detail provided by Morrison and Hoffman (1988) and Meade (1989) who attempted to enumerate every step and every possible combination of steps was avoided as impractical for research in gunnery performance. Thus, limits were placed on the amount of detail given in order to provide a set of performance constructs that can be use to compare devices and prepare training strategies.

Morrison et al. (1990) first identified 13 major subgoals of crew gunnery. These were derived from a modification of the Hoffman and Morrison (1988) scheme and were supported by the details of Morrison and Hoffman (1988) and Meade (1989). These are presented in Table 1. Within each subgoal, the component activities, called subtasks, were identified. For example, the gunnery subgoal "acquire targets" includes subtasks such as search open hatch, estimate range, gunner search using thermal sight, and identify target. (The Prepare Tank subgoals were not further considered.)

Table 1

Crew Level Subgoals

Prepare Tank
Acquire Target(s)
Issue Fire Command
Engage Single Main Gun Target Using Precision Gunnery
Engage Single Coax Target Using Precision Gunnery
Engage Single Target under Degraded Conditions
Engage Target from TC Position
Engage Target from Loader Position
Engage Multiple Targets
Adjust Direct Fire
Take Immediate Action
Employ Smoke
Report

Platoon-level activities were broken up into platoon subtasks and platoon leader subtasks by Morrison et al. (1990). The platoon subtasks were subsequently grouped into two subtask clusters, movement and engagement, by Morrison and Holding (in preparation) for use in organizing training. The platoon leader subtasks may be performed by either the platoon leader or the platoon sergeant; however, for simplicity these tasks will be termed "platoon leader" subtasks. Platoon and platoon leader activities are presented in Tables 2 and 3, respectively.

Table 2

Platoon Subtask Clusters and Subordinate Subtasks

Movement
Travel in Formation
Bound by Section
Overwatch a Bounding Platoon
Occupy a Battle Position
Maneuver within a Battle Position
Engagement
Battle Drills
Employ Fire Patterns
Employ Firing Techniques

Table 3

Platoon Leader/Platoon Sergeant Subtasks

Platoon Fire Commands
Indirect Fire Requests
Platoon Movement Commands

To facilitate the design of training organization, Morrison et al. (1990) also clustered the crew subtasks based on their similarity on a number of training requirements, tempered with their similarity in gunnery subgoals. Training requirements included fidelity requirements for training media plus information processing and psychomotor requirements for the learner. Clusters were derived within position for tank commander, gunner, and loader. Driver subtasks were homogeneous across the gunnery subgoals and could not be differentiated. The cluster patterns for the different positions were reviewed for similarity.

As a result of the clustering, several levels of specificity were created by Morrison et al. (1990) to describe crew gunnery activities. Figure 1 shows the relationship between these levels. Although these clusters were formed by analyzing lower level sub*tasks*, each cluster tended to contain subtasks from common sub*goals*. Therefore, instead of listing the subtasks for each goal, the subgoals are listed. Thus, a two level working structure for crew gunnery activities was created. Table 4 presents the structure. The subtask clusters are identified by the major headings.[1] The subgoals they subsume are listed below.

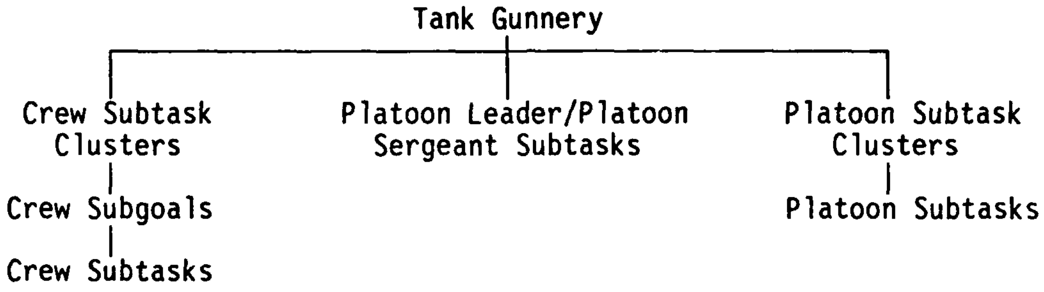

Figure 1. Relationship between levels of crew, platoon leader, and platoon gunnery activities.

Threat Context

While these crew, platoon, and platoon leader gunnery structures can be treated independently, in keeping with the directive to train in a realistic context (FM 25-100, Department of Army, 1988c), a set of threat conditions is also incorporated into the gunnery domain. These conditions are a representative sample of the types of threat arrays that might be faced by a tank platoon. These were developed by Doyle (1990).

Doyle (1990) used the threat analysis methodology provided by Campbell and Campbell (1990) to describe and organize the threat in terms of the vehicles, formations, and deployment densities representative of combat engagements. Threat-based target arrays resulted that describe threat capabilities in a framework that considers various levels of those conditions.

[1] TC switchology cluster for Morrison et al. (1990) was renamed to more easily differentiate it from the switchology for gunners.

Table 4

Crew Subgoals Organized by Subtask Cluster

Target Acquisition (TC and Loader)	
	Target Acquisition
Engagement Initiation/Fire Command (TC)	
Engagement Control Procedures (TC)	
	Adjust Fire
	Control Movement
	Report
	Smoke
"Switchology" Procedures (TC and Gunner)	
	Engage Main Gun
	Engage Degraded - Settings
	Engage from TC Position
	Engage Multiple Targets
Manipulation of Gun Controls (TC, Gunner, Loader)	
	Acquisition - Gunner
	Engage with Main Gun
	Engage with COAX
	Engage Degraded - Manipulations
	Engage from TC Position
	Engage from Loader Position
	Engage Multiple Targets
Degraded Modes (TC and Gunner)	
	Engage Degraded - Selection of Procedures
Immediate Action (TC and Gunner)	
	Immediate Action
Maneuver Tank (Driver)	
	Includes driver subtasks from all gunnery subgoals

Six sets of threat engagements were prepared. Each set describes a different combination of Red (threat) mission against Blue mission. These include:

- Red Meeting Engagement versus Blue Attack
- Red Meeting Engagement versus Blue Defense
- Red Attack versus Blue Defense
- Red Deliberate Defense versus Blue Attack
- Red Withdrawal versus Blue Attack
- Red Breakthrough versus Blue Defense

For each of these sets, seven separate Red deployments or engagement diagrams were depicted. For all but the Red Breakthrough condition, an initial engagement diagram shows the full threat (Motorized Rifle Company reinforced) at a range just beyond the effective range of the M1A1 tank. For the breakthrough, an initial diagram shows the threat at the time of the breakthrough. Additional engagement diagrams were prepared to depict changes in Red formations at three ranges subsequent to the initial condition. In these subsequent engagement diagrams, Red vehicles were reduced from original levels to represent the attrition of Red vehicles. To allow for two levels of difficulty of engagements, two subsets of subsequent engagements were prepared for each of the six mission combinations. One set shows a high Red loss rate resulting in relatively few Red vehicles. The other shows a low Red loss rate with relatively more Red vehicles in the snapshots. Thus, for each of the basic six mission combinations, seven engagements were developed: an initial diagram and six subsequent diagrams that show Red formations that result when two attrition rates are applied to three subsequent ranges. Thus, a total of 42 engagement diagrams were prepared. An example is presented on the following pages as Figure 2 and Figure 3.

These 42 engagements include only threat ground forces and omit consideration of a number of battlefield conditions that affect tank gunnery. Thus, a number of additional conditions, called engagement enhancements, were developed that could be added to any of the 42 engagement descriptions. These engagement enhancements include fixed-wing aircraft, helicopters, chemical conditions, counter mobility (obstacles), smoke, artillery, and electronic warfare.

Morrison et al. (1990) initiated a crosswalk between the crew, platoon, and platoon leader subtasks and threat engagements to show sample threat contexts in which each of the gunnery subtasks occur. Thus, a two dimensional matrix was created with engagements on one dimension and crew, platoon, and platoon leader subtasks on the other. The cells of the matrix indicate the possibility of a subtask occurring under the conditions described by the engagement. Campbell and Hoffman (1990) have simplified that matrix by collapsing engagements that have similar subtask requirements. The result is a smaller subtask by engagement cluster matrix. It was this matrix that Campbell and Hoffman used as the basis for selecting engagement conditions to support testing crew or platoon proficiency on any of the subtasks.

Summarizing the gunnery domain has been a rather intricate activity. Hoffman and Morrison (1988) earlier characterized the learning hierarchy of crew gunnery domain as wide but not very deep, meaning that there are a lot of components to gunnery but few of them are tied together in any structure of learning prerequisites. Similarly, there are a variety of activities unrelated in physical or cognitive demands. Any correlation that might be observed in performance across many of the parts of the domain is probably not attributable to similarity in common knowledge or common skills. What we are attempting to do is sort out these independent pieces so that gunnery research can focus on relationships that may be expected from common knowledge or skills.

Subsequent Scenario Brief 3.1: Red Meeting Engagement vs. Blue Attack

Threat Unit:	Motorized Rifle Company (Reinforced) from the Advance Guard Main Body
Range Line:	Line 1: 2000 meters
Loss Rate:	High - 3 systems (3 systems cumulative)
Threat Composition:	3 T-80 tanks 7 BMP-2 Armored Infantry combat vehicles with AT-5, 30mm automatic gun, carrying rifle squads of 7 troops and one RPG-14 each 1 BMP-2 with AT-5, carrying weapons squad of 7 troops with 2 AGS-17 automatic grenade launchers 1 BMP-2 with AT-5, carrying anti-aircraft squad of 4 troops with 3 SA-14 1 BMP-2 with AT-5, command vehicle

Threat Disposition at 2000 meters:

The threat unit remains in a company wedge. Platoons remain in column, but prepare to move up on line behind the tanks.

The weapons squad begin to slow, looking for cover where they can emplace their AGS-17s on the ground.

The overall formation is 400 meters wide, by 800 meters deep.

Figure 2. Description of sample threat target array.

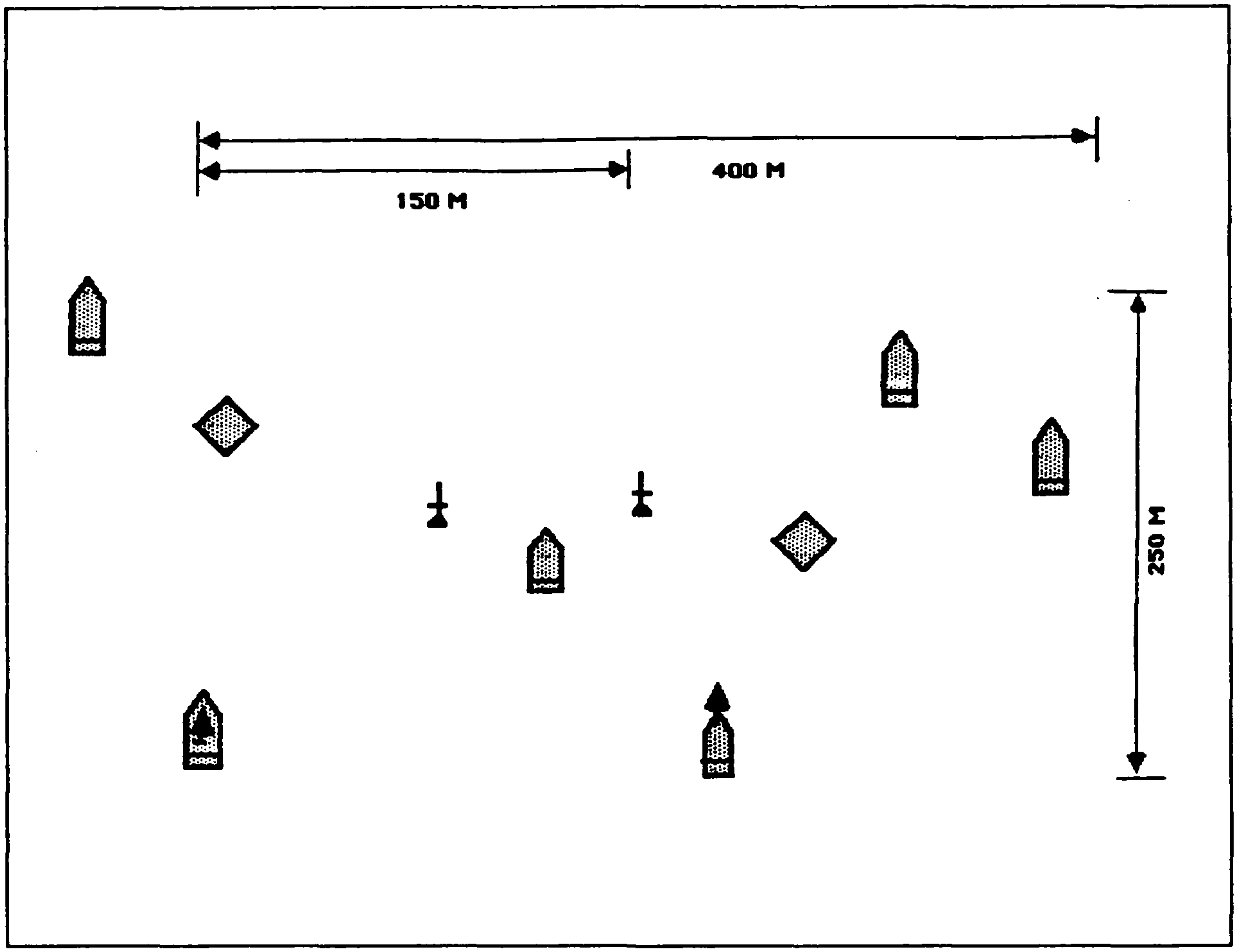

Figure 3. Sample threat target array: Diagram.

Testing Concept

The above discussion suggests that a gunnery criterion test be segmented into eight components defined by three parameters. The first parameter is firing mode. Despite its recognized deficiencies as a testing mode (Hoffman, 1989; Hoffman & Morrison, 1988; Powers et al., 1975), live-fire is viewed by the armor community as the paramount exercise for gunnery. However, safety and resource limitations place constraints on the utility of live-fire exercises for reliably testing the complete domain of gunnery. Thus, instrumented dry-fire exercises will be used to augment live-fire exercises. The second parameter is the source for selecting target arrays for the test. Two sources are available including the threat analysis conducted by Doyle (1990) and the Tank Tables for crew and platoon from FM 17-12-1. Each target source will be used. The final parameter is the echelon of skills to be tested. That is, components of the criterion test will cover both crew and platoon level skills. Thus, the gunnery criterion test will comprise three parameters each with two levels of conditions for a total of eight separate components. These are (a) skill echelon (crew/platoon), (b) target base

(Combat Tables/threat arrays), and (c) firing mode (live-fire/instrumented dry-fire). The skills that can be tested within each component will vary as a direct function of the three parameters. Figure 4 depicts the eight components of the gunnery proficiency test.

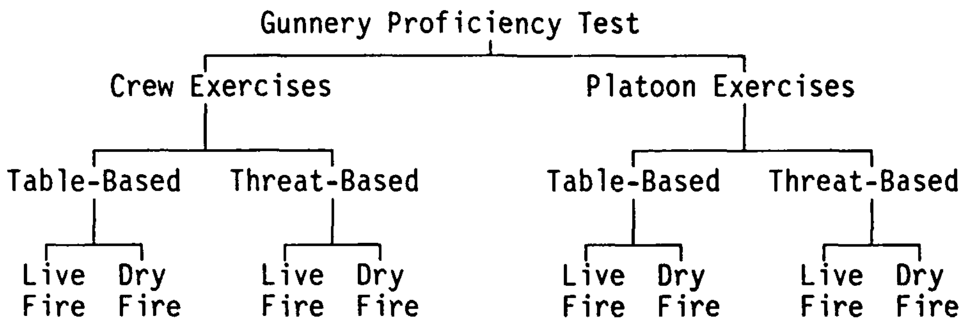

Figure 4. Components of a comprehensive tank gunnery assessment.

Needs

Thus, motivation for creating a comprehensive gunnery test is documented, and the gunnery domain resource is provided. There remain, however, a number of activities to create such a test. First, we need to consider how to score performance in each of the major areas of gunnery. That is, issues concerning what to score need to be thoroughly explored. Second, the issue of setting standards for performance must be explored, including the role of standards in training research and the construction of standard setting procedures for the components of the gunnery domain.

Note that we are explicitly separating the design of measurements of gunnery performance from the process of setting standards for performance. Under the current Army training development system these two issues tend to be confused. That is, "standards for performance" often refer to a checklist of performance steps. From our perspective, such a checklist serves as a rating scale for measuring performance that can be scored as percent of steps performed correctly. For research purposes, such a scale, without explicitly setting a passing mark, is most useful for differentiating performance. Standard setting is the activity that determines what level of performance is acceptable. A similar confusion occurs in the training research literature where "training to criterion" is a common strategy. In this sense, a "criterion" implies a particular level of performance. An alternative meaning comes from the performance measurement literature where a "criterion" simply means a performance dimension (represented by either an actual measurement scale or by a conception) on which performance is measured. In this case, no level of acceptability is implied. Again, for research purposes, scoring performance across a wide range of levels allows for conclusions that may be missed if performance is dichotomized to pass and fail categories. Thus, measurement design and standard setting are treated as separate issues in this report.

Following the presentation of measurement specifications and standard setting issues, training devices to support testing are discussed. This includes an initial evaluation of what devices can support testing of gunnery performance. Finally, these issues must be merged into a gunnery performance assessment package for crew and platoon gunnery.

Chapter 2. Requirements for Tank Gunnery Proficiency Metrics

In previous research, we developed a number of useful concepts for determining the type of measurement approaches that should be used for assessing tank gunnery proficiency. A number of these issues will be considered for the gunnery domain outlined in Chapter 1.

Basic Issues in Gunnery Testing

Hoffman and Morrison (1988) discussed two basic purposes of testing: (a) to provide an overall assessment of performance proficiency and (b) to provide a diagnostic assessment of performance deficiency. A primary difference between the two is in the kind and detail of the scoring procedures. For example, outcome measures (e.g., target hits) may be useful for proficiency assessment, but they provide very limited diagnostic information.

Hoffman and Morrison (1988) began with a simple model relating conditions, knowledge, job behavior, and behavior outcomes (see Figure 5). In the model, job behavior is the product of individual (or crew) knowledge applied to a set of environmental conditions. Performance outcomes are determined by the appropriateness of the behavior for the environmental conditions. Using this model, Hoffman and Morrison developed classification rules called "factors affecting measurement mode selection for testing" concerning knowledge requirements, behavior requirements, and the association between behaviors and outcomes (see Table 5) that affect the information requirements of diagnostic and proficiency tests. Twelve types of performance elements were then identified and measurement requirements specified for each element (see Table 6).

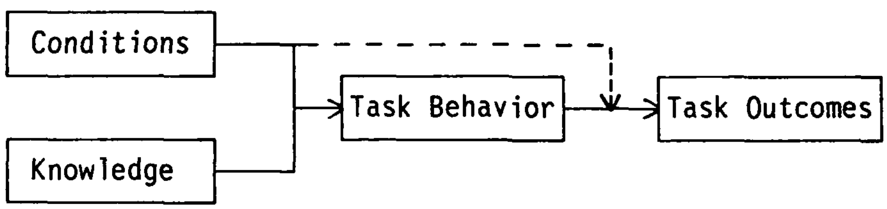

Figure 5. Task performance model.

Table 5

Factors Affecting Measurement Mode Selection for Testing

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1. Cognitive requirement:

   a. Linear procedure, simple reaction. The task is done essentially the same way each time. Task performance requires no decisions, other than the one that initiates performance.

   b. Decisions and behavior adjustment required. Task procedures depend on various contingencies that must be attended to during task performance. Decisions made during task performance will alter performance behaviors. Assessment of the appropriateness of choice is needed to diagnose incorrect performance.

2. Behavior requirement:

   a. Overt:

      1. Simple. If the knowledge of what to do is present or if step by step instructions are given, the behavior can be performed with little or no practice. Practicing the task is most important for cognitively acquiring the procedure (i.e., memorizing the steps). Assessments of task knowledge can be used to infer task proficiency.

      2. Complex. The behavior *per se* is difficult to perform correctly. Persons may know what to do or may be told what to do, but without being told how to execute the behavior and without practicing the behavior, they are unable to perform effectively. Practicing the task is necessary both for memorizing the steps and for learning to execute the behavior. Direct assessment of behavior is needed to diagnose incorrect behavior, but knowledge tests may be needed to separate errors caused by deficits in knowing what to do.

   b. Covert. Behavior involves observing or analyzing. There are no observable behaviors or outcomes. Tasks in this category may initiate subsequent, observable tasks such giving a report or a command. Measuring performance may involve interrupting performance to assess the information gained during task execution or may involving assessing the follow-on task.

3. Association of outcomes with task behavior:

   a. Task outcomes are strongly associated with task behavior: outcomes are primarily dependent on behavior. Outcome measures are sufficient indicators of task proficiency and may be used for performance diagnoses if the task behavior is simple.

   b. Task outcomes are weakly associated with task behavior: outcomes are heavily dependent on factors other than individual's (or crew's, or platoon's) behavior. Outcome measures are too contaminated to be certain about the behavior that took place. Therefore outcome measures cannot be used for measuring proficiency or for diagnosis.

   c. Alternative associations. There are alternative behaviors for obtaining desired outcomes. One cannot infer what behavior took place from observing outcomes, but proficiency can be assessed from the outcomes.

Note. From "Requirements for a device-based training and testing program for M1 gunnery: Volume 1. Rationale and summary of results" (p.43), by R. G. Hoffman and J. E. Morrison, 1988, Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Table 6

Measurement Specification Rules

Task Type	Decision	Behavior	Behavior/ Outcome Association	Measurement Requirement[a]
Overt Behaviors:				
1.	No	Simple	Strong Assoc.	K, B, or O will suffice
2.	No	Simple	Weak Assoc.	K or B will suffice
3.	No	Complex	Strong Assoc.	B necessary for diagnosis; O for proficiency only
4.	No	Complex	Weak Assoc.	B necessary
5.	No	Either	Alternative associations	B and O necessary
6.	Yes	Simple	Strong Assoc.	B or O may suffice, but K may be required to efficiently test all task options.
7.	Yes	Simple	Weak Assoc.	B may suffice, but K may be required to efficiently test all task options.
8.	Yes	Complex	Strong Assoc.	O may suffice for proficiency, but K and B necessary for diagnoses.
9.	Yes	Complex	Weak Assoc.	B may suffice for proficiency, but K and B necessary for diagnoses.
10.	Yes	Either	Alternative associations	O may suffice for proficiency, but K, B, and O may be needed for complete diagnoses.
Covert Behaviors:				
11.	No	Observing	(Information)	K for new information, or assessment of follow-on task.
12.	Yes	Analyzing	(Information)	K for analysis rules for new information; O for assessment of follow-on task if strong association.

Note. From "Requirements for a device-based training and testing program for M1 gunnery: Volume 1. Rationale and summary of results" (p.44), by R. G. Hoffman and J. E. Morrison, 1988, Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. Adapted by permission.

[a]K = Knowledge assessment; B = Behavior assessment; O = Outcome assessment.

There are two important observations from these tables. The first is that construction of a performance test is complicated by the need to consider all three domains (knowledge, behavior, and outcomes) in light of the goal of testing (diagnostic or proficiency). The second observation, which is particularly important for measuring tactical gunnery, is that outcome assessments are inappropriate for several types of tasks but necessary for several others. The decision to use outcome measures cannot be made on a simple preference for win/lose or hit/miss criteria but must be made by reasoned judgement about the quality of information obtained from such measures.

Specification of Measurement Types for Crew Gunnery

The gunnery domain, presented in Chapter 1, is much more complex than the simple model in Figure 5. Therefore, before applying the measurement specification rules, the performance model was elaborated to include the gunnery subtask cluster organization presented in Table 2. Figure 6 presents an organization of the subtask clusters in relation to one another.

The model appears as a basic path diagram illustrating the flow of activities culminating in target hits and survival. The process of tank gunnery is a chain of events occurring in a background of threat and environmental conditions. Outcomes for some clusters are the behaviors for subsequent clusters. Because of this linkage, there may be several levels of outcomes, some more closely associated with the activities of the subtask cluster than others. For example, the outcomes associated with the TC giving a fire command are the initiation of a number of crew behaviors associated with other subgoals. The figure also illustrates that, at a higher level of analysis, the overall goals of crew gunnery are to hit targets and survive the battle. In contrast, research comparisons of training strategies are concerned with differences in overall proficiency (hits and survival) as well as differences in subtask cluster proficiency.

Approaches for Crew Subgoal Cluster Measurement

Based on the measurement specification rules, Table 7 indicates recommended types of measurement for the crew subtask clusters. There are several observations to be made, the first of which is that the recommendations were made with a recognition that the purpose of testing is to support gunnery training research. The test data will be used primarily to differentiate groups of crews and platoons that receive different amounts and kinds of training rather than to pinpoint specific weaknesses of particular crews and platoons. M1 tank gunnery is rather intricate at its most detailed level, and there are myriad ways in which a crew or platoon can make mistakes. For training *per se*, it may be necessary to capture all of those details. However, for training strategy research, detail at the subgoal cluster level is sufficient to differentiate between alternative training devices and strategies. Therefore, recommendations in Table 7 are rather broad but nevertheless sufficient for research purposes.

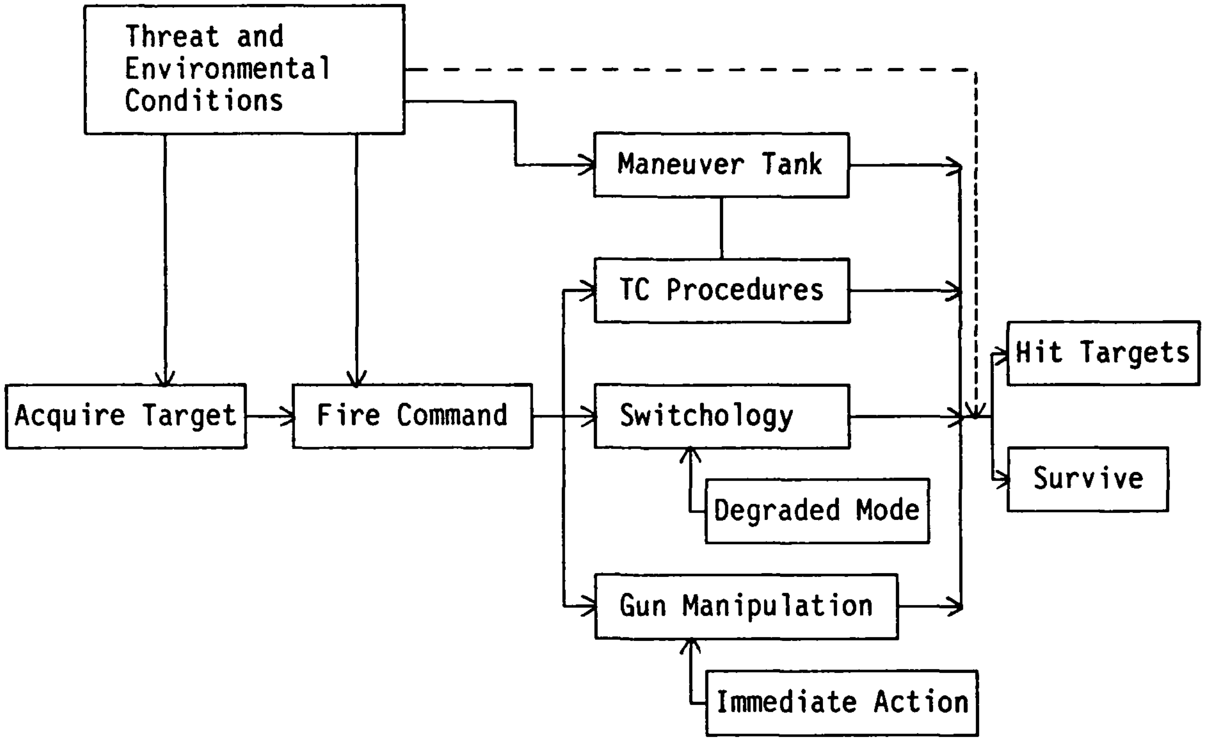

Figure 6. Model of crew gunnery for analyzing performance measurement needs.

Second, each subgoal cluster is treated as if it comprised only one task. This is obviously not the case because each cluster comprises a number of subtasks that in several cases involve the activities of several crew members. On the other hand, each cluster comprises a set of related activities with the same outcome objective and the same type of association between the behaviors and outcome. Therefore, measurement specifications can be made at the subtask cluster level. They do not have to be made for each subgoal or for each subtask.

Third, several crew subtask clusters seem to reflect a two-step process: the first step is covert, and the second is overt. For example when acquiring targets, one must first look for the target - a covert perceptual process. Once the target is found, other crew members must be informed of its location by an overt announcement. According to the measurement specification rules, a knowledge test may be the only method for independently assessing covert behavior. However, because the covert behavior of searching is directly linked to an overt announcement, it is possible to assess the target acquisition by measuring the response delay and accuracy of announcing target location (for gunner, loader, or driver) or response delay and accuracy of the fire command. In other words, the speed and accuracy with which a target was announced measures covert target acquisition as well as the overt behavior o'

Table 7

Measurement Specifications for Crew Subtask Clusters

Crew Subtask Cluster	Dominant Behavior	Behavior Type	Outcome(s)	Behavior/Outcome Association	Measure[a]
Target Acquisition	a. Acquire target	Observe	Target info.	-[b]	
	b. Announce target	Simple	Crew reacts	Weak Assoc.	B: Announcement speed & accuracy
Fire Command	a. Decision	Analyze	Give command	-	
	b. Give command	Simple	Crew reacts	Weak Assoc.	B: Announcement speed & accuracy
TC Engagement Control Procedures	a. Decisions	Analyze	Engagement perception	-	
	b. Give command	Simple	Crew reacts	Weak Assoc.	B: Announcement speed & accuracy
"Switchology"	Set switches	Simple	a. Switches set	Strong Assoc.	O: Switch settings
			b. Target hits	Weak Assoc.	O: Target hits
Weapon Manipulation	Track & fire weapon	Complex	a. Sight picture & computer set	Strong Assoc.	O: Sight picture & ballistic solution at time of firing
			b. Target hits	Weak Assoc.	O: Target hits
Degraded Modes	a. Decision(s)	Analyze	Pertinent control info.	-	
	b. Make announcement	Simple	Crew reacts	Strong Assoc.	B: Announcement speed & accuracy
Immediate Action	Manipulate weapon	Simple	Weapon clear	Strong Assoc.	O: Weapon status
Maneuver Tank	Move tank	Complex	Proper position	Strong Assoc.	O: Own tank position

[a]B = Behavior assessment, O = Outcome assessment.

[b]Covert behavior (Observe/Analyze) assumes a strong behavior/outcome association, but the outcome is not observable.

informing crew members of the target's existence and location. The same logic applies to the behavior assessment of "Switchology" - TC Commands, Target Engagement - TC Commands, and Degraded Modes - Selection.

Fourth, it was necessary to consider more than one level of outcome for several of the subtask clusters. For example, the correct immediate outcome of the switchology subtask cluster is that the tank fire control switches are set appropriately. A subsequent outcome is that targets are hit. The first outcome is strongly associated with the switchology behaviors, so that recording switch settings and comparing them to required switch settings is the most valid method of assessing proficiency. On the other hand, the second outcome, while rated as weakly associated with switchology behaviors, carries sufficient information, if targets are being hit. That is, targets can only be hit consistently if switch setting are correct. Therefore, hitting targets

implies correct switch settings. Consistently missing targets, however, does not imply that switches are incorrectly set. Deficiencies in weapon control manipulation or undetected malfunctions can also cause rounds to miss. Thus, for several of the subtask clusters, partial information on subtask cluster proficiency is carried by the overall outcome of target hits.

Approaches for Platoon Subtask Measurement

For the platoon, the analysis has changed from a focus on persons to a focus on tanks. That is, a platoon performance model treats tank activities as the unit of analysis (see Figure 7). While platoon movement and platoon firing are ultimately the result of crew behaviors, it is the coordination among the tanks that is significant at this level of analysis.

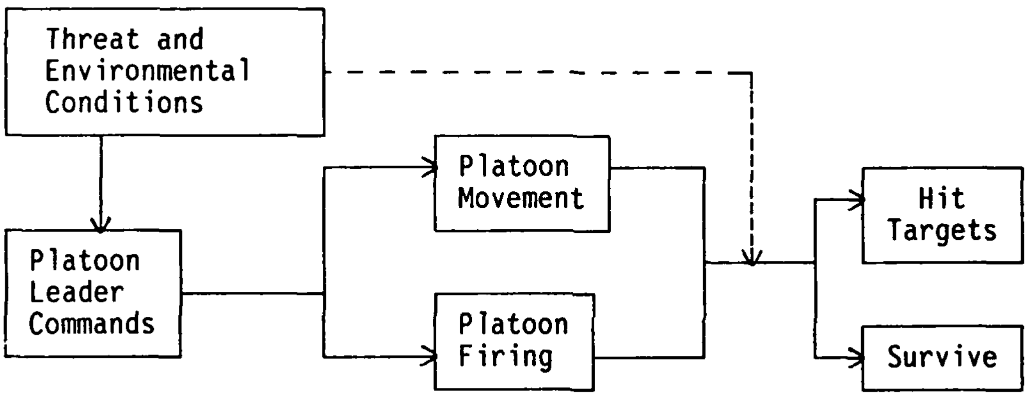

Figure 7. Model of platoon gunnery for analyzing performance measurement needs.

Table 8 indicates measurement recommendations based on the measurement specification rules for the platoon leader subtasks and for the platoon subtask clusters. Again, recommendations were made broadly. Thus, because all of the platoon leader subtasks involve analysis and reporting, the set of platoon leader subtasks was treated as one unit. At the platoon level, the movement and engagements subtask clusters were examined.

Table 8

Measurement Specifications for Platoon Level Subtasks

Platoon Level Subtask	Dominant Behavior	Behavior Type	Outcome(s)	Behavior/Outcome Association	Measure[a]
Platoon Leader	a. Decision(s) b. Give command	Analyze Simple	Give command	--[b]	B: Announcement timeliness and accuracy
Platoon Movement	Move in proper formation & position	Complex	a. Facilitate target hits b. Survival	Weak Assoc.	B: Relative positions and movements of tanks
Platoon Engagement	Position & coordinate fire	Complex	a. Hit targets b. Survival	Weak Assoc.	B: Relative positions O: Hits and fire distribution

[a]B = Behavior assessment, O = Outcome assessment.

[b]Covert behavior (Observe/Analyze) assumes a strong behavior/outcome association, but the outcome is not observable.

The platoon leader behaviors each involve analysis of the situation followed by a command or request. Analogous to the TC's fire command, the appropriateness of the outcomes of these announcements are dependent on other factors (e.g., how the crew or platoon reacts) and cannot be used to assess unequivocally platoon leader proficiency. Thus, while the platoon leader may issue an appropriate fire command, the platoon may execute it incorrectly. Thus, assessment of the platoon leader's announcements is the recommended measurement approach.

For the platoon, recommended measurement approaches indicate the need to assess tank movement and positioning, target hits overall, and fire distribution (target hits by tank). Tank movement and position is labeled "behavior assessment" in accordance with the specification rules in Table 6. A more appropriate interpretation is that these are recommendations to assess gunnery "process."

An Overall Metric of Gunnery Proficiency

The above analyses look at the components of gunnery without explicitly considering gunnery as a whole. Overall gunnery proficiency is undoubtedly some function of the sum of the parts of gunnery, but there is no known function. That is, there is no unequivocal formula for combining performance measures from each of the gunnery subgoals and deriving an overall gunnery composite score. Hoffman and Witmer (1989) have analyzed crew gunnery in terms of a composite crew gunnery score which focuses on the outcomes of gunnery. They began with the following assumption.

"The goal of gunnery is to

- *hit as many threat targets as possible,*
- *with as few rounds as possible,*
- *in as short a time as possible,*
- *in order of threat magnitude, and*
- *without hitting friendly vehicles.*" (p. 16)

Each facet of this multifaceted statement was examined in an attempt to justify a single score that would capture the goals of gunnery. They reached a compromise solution that, under certain assumptions related to the test medium with which they were dealing, captured aspects of each facet. The solution was to assess hit rate (hits per unit of time) on a standardized set of targets and deduct a penalty for hitting friendly vehicles. As discussed in the following paragraphs, two facets were particularly difficult to incorporate in a single metric.

First, minimizing rounds used (in terms of maximizing hit percentage) is not directly incorporated in hit rate. That is, a crew can, in theory, achieve an acceptable hit rate if it can fire fast enough to make up for a low hit percentage. On the other hand, during a test with a relatively short target exposure time such a crew would probably not be able to make up the difference. More important, if rounds for the test are limited in relation to the number of targets, low hit percentages will result in lower hit rates because such crews will run out of ammunition before they run out of targets.

Second, hitting targets in order of threat magnitude is not included in hit rate. This facet of the gunnery composite pertains to survival, thus survival has been listed separately in each of the performance models. The issue of survival is obviously related to platoon performance but also to the capabilities of the threat. This issue is explored more fully in the following chapter.

Conclusions

Chapter 1 mentioned several problems associated with Table VIII assessment of gunnery performance. Several other important issues result for the nature of the gunnery domain. For example, the gunnery domain was characterized in Chapter 1 as broad but not very deep. That is, there are a wide variety of things to know and do related to gunnery, and familiarity with one area provides little information about performance in others. The implication for test construction is that there must be systematic inclusion of a variety of different conditions and types of scoring criteria (i.e., knowledge, behavior, and outcomes). The outcomes of gunnery result from a variety of elements some of which are not totally under the control of the crew. Shortcuts to measuring performance by examining only outcomes can easily be misleading.

The key findings from the above analyses were to identify which aspects of gunnery can be assessed by hits on targets and which aspects need to be assessed by evaluations of the gunnery process. Both process and outcome measures are needed. Table 9 presents a brief summary of the recommended type of performance measurements for use in gunnery training research.

Table 9

Summary of Measurement Recommendations for Assessing Crew and Platoon Gunnery

Level of Analysis	Recommendations	
	Process Measures	Outcome Measures
Crew Activities		
Target acquisition	Speed (timeliness) and accuracy of commands	
Fire commands	Speed and accuracy	
TC control procedures	Speed and accuracy	
Switchology		Switch settings, Target hits
Weapon manipulation		Sight picture, Target hits
Immediate action		Weapon status
Maneuver tank	Own tank position/ Movement	
Platoon Leader Activities		
Commands	Speed (timeliness) and accuracy of commands	
Platoon Activities		
Movement	Relative positions and movements of tanks	
Firing	Relative positions and movements of tanks	Target hits, Fire distribution, and Survival
Overall Crew Proficiency		Target hits, Round conservation, and Survival
Overall Platoon Proficiency		Target hits, Round conservation, and Survival

Measurement recommendations were made for each subtask cluster and for gunnery as a whole. For the subtasks, both process and outcome measures were indicated. In the following chapters, specific measures for these areas are developed, and methods for setting standards on the measures are outlined. Because the issues pertaining to hit criteria are very different from those related to the other measures, a separate chapter is devoted to hit criteria. For hits, issues of measurement and issues of setting performance standards are closely tied together, and both areas will be covered in the next chapter. Following discussion of target hits, measures for the remaining areas of gunnery performance will be presented followed by a presentation of the procedures for setting standards on these measures.

Chapter 3. Target Hit Criteria in Gunnery Performance

This chapter addresses the measurement of crew and platoon gunnery performance by assessing the speed and accuracy with which targets are hit. The issue is complicated by two factors. First, in recent years scoring speed and accuracy has been so closely tied to standards of performance that performance scores are expressed in terms of standards. While measurement and standard setting are separable, they are sufficiently intertwined that this chapter addresses both issues simultaneously. Second, there are a number of questions related to the types of target arrays that are engaged.

Sustained speed and accuracy of hitting targets is the dominant objective of tank gunnery. To this end, current scoring of gunnery tests in Tank Tables VIII and XII emphasize speed of hitting targets. In the early 1980s, a shift was made in the basis of the scoring methodology of Tank Table VIII.[2] Performance scores are now expressed in terms of performance against an identified threat such that scores are scaled against estimated threat capabilities. In this manner, speed and accuracy have direct implications for survival, and survival becomes the basis for setting performance standards for speed and accuracy.

In addition to the Table VIII threat-based scoring methodology, there are two other recent attempts to apply threat-based scoring algorithms to armor gunnery. A careful review of each of these efforts uncovered a number of issues regarding methods for assessing gunnery performance relative to threat capabilities. The basic theme for each approach is that observed performance for Blue tanks is compared to estimated Red (threat) capabilities. There are, however, significant variations on that theme.

Current Approaches to Speed and Accuracy Scoring

Tank Table VIII

Table VIII consists of one-on-one and two-on-one engagements (i.e., one or two Red targets for one Blue tank). Blue performance, in terms of the time it takes to hit each target, is scored by a procedure that represents two critical aspects of gunnery: (a) target hits and (b) survival. Estimates of each are based on a comparison of observed Blue performance and expected Red capability. Estimated Red capability is derived from one-sided modeling of Red time to fire and hit accuracy capabilities. Data from the models are then used to construct cumulative hit probability distributions which indicate probabilities of Blue being hit by a Red vehicle as a function of elapsed

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[2]Information on the Table VIII scoring methodology was obtained in an unpublished document titled "Tank Table VIII Scoring Methodology," dated May 10, 1984 provided by Mr. Al Pomey at the TEXCOM Armor and Engineer Board, Ft. Knox, KY. The authors and originating organization are unspecified; however, a number of personnel from the U.S. Army Armor Center and School were active in the development of the concept.

time.[3] Separate distributions are derived for threat tanks and BMPs, for offense and for defense, and for different ranges to the targets. From these cumulative hit probability curves, hit expectations of Blue on Red are used to estimate Blue's hit capability, and hit expectations of Red on Blue are used to estimate Blue survival. In essence, hit expectations for both Blue on Red and Red on Blue are the probability of hitting multiplied by the number of targets to be hit, where the probability of hitting is based on Blue exposure time and Red capability.

Expected Blue hits on Red is not simply a count of Blue hits. Rather, it is a count of Blue hits on Red discounted for the probability that, had the Red been shooting back, Blue might not have survived long enough to have hit those Red targets. For an engagement with one Red target which is hit by the Blue, the hit expectation for Blue on Red is simply 1 (the number of Red targets hit by Blue) multiplied by the survival probability for Blue given the time it was exposed. For one Red target which is not hit by Blue, the hit expectation is zero. For engagements with two Red targets, the calculation is somewhat more complex (see The 1-on-n algorithm, p. 41), but again the result is a function of observed hits and the probabilities of surviving long enough to hit each target in the observed times. Note that the resulting number will not necessarily be an integer but can be any value between zero and the number of targets. Thus, for the one-on-one engagement, expected Blue hits on Red can vary from zero to one. Obviously, in actuality the Blue either hits the Red or it doesn't. However, the hit expectation measure is just that, an *expectation.* In this sense, it is an average value that answers the question: What would Blue's hit average be if it were to repeatedly perform as observed and if the Red were shooting back?

Blue survivability is estimated by calculating expected Red hits on Blue. Expected Red hits on Blue is simply the probability that Blue would have been hit by the Red in the time Blue was exposed. For two target engagements, the cumulative hit probabilities of each Red are combined to yield an estimate of the Blue being hit by either Red target. Again, the index is an *expectation* that addresses the question: If the Blue tank were to repeatedly perform as observed, what would the Red's hit average be?

These two hit expectations (Blue on Red and Red on Blue) can be interpreted in different ways. Expected Blue hits on Red is also an estimate of Red losses, and expected Red hits on Blue is an estimate of Blue losses. Thus,

$$E\ (\text{Red hits}) = E\ (\text{Blue loss}), \text{ and} \tag{1}$$
$$E\ (\text{Blue hits}) = E\ (\text{Red loss}). \tag{2}$$

In addition, because there is only one Blue vehicle, E (Blue loss) can be used to define expected Blue survivability:

[3]For Table VIII and each of the other methods described below, probability of a kill given a hit is assumed to be one. The rationale is that because Blue hits on a panel target are all counted as kills, estimates of threat capabilities should be given the same advantage. This implies equal lethality and protection levels for Red and Blue systems.

$$E\ (\text{Blue survivability}) = 1 - E\ (\text{Blue loss}). \tag{3}$$

For more than one Red target, an analogous interpretation for Red survival is not appropriate. For example, expected Red loss for a given Blue performance may equal 1.5 which when subtracted from one gives an obviously erroneous survival value of -.5.[4]

The ratio of expected Blue hits on Red divided by expected Red hits on Blue can be interpreted as a hit expectation ratio (expected Blue hits divided by expected Red hits) or as a loss expectation ratio (expected Red losses divided by expected Blue losses). Table VIII developers refer to the ratio as a hit expectation ratio. Alternatively, it can be interpreted as representing Blue hits and Blue survival (Blue hits divided by 1-Blue survival). To indicate its emphasis on Blue proficiency this last interpretation is simply called a "performance ratio." Figure 8 presents these different interpretations.

A. Hit Expectation Ratio = $\dfrac{\text{Expected Blue Hits}}{\text{Expected Red Hits}}$

B. Loss Expectation Ratio = $\dfrac{\text{Expected Red Losses}}{\text{Expected Blue Losses}}$

C. Performance Ratio = $\dfrac{\text{Expected Blue Hits}}{1 - \text{Probability of Blue Survival}}$

Where:

Expected Blue Hits = Expected Red Losses, and

Expected Red Hits = Expected Blue Losses = 1 - Prob. of Blue Survival

Figure 8. Alternative and equivalent interpretations of the hit expectation ratio concept.

[4]Expected (Red Loss) could be subtracted from total Red targets to estimate the expected number of Red surviving. Expected Red surviving could then be divided by total Red to give an estimate of the proportion of Red expected to survive. One could then construct a survival ratio. Such an index has the same limitations as a hit expectation ratio and there is nothing to be gained from it.

It is important to note that expected Blue hits and expected Red hits are not redundant. Two Blue tanks can fire the same engagement with different times, have the same expected hits on Red, but different survival expectations. Or, two Blue may receive that same survival expectation but different expectations for hitting Red targets. The concept here is a micro version of the World War II and National Training Center (NTC) observations that some tanks are involved to a greater extent in hitting threat targets than others. The implicit implication is that the non-killers may be more survival oriented. The Table VIII hit expectation score, by representing both hits and survival, evaluates tank crews on their respective abilities to *both hit and survive* targets.

An alternative interpretation of the hit expectation ratio that exists in the Armor community is to view the hit expectation ratio as a win probability. This interpretation, however, holds only for one-on-one engagements. In this case, expected Red hits on Blue represents the probability of the Red defeating the Blue, given Blue's exposure time. When there is only one Red target, expected Blue hits on Red represents the probability of Blue defeating the Red in the observed exposure time. Thus, for one-on-one engagements, the ratio can be interpreted as a win ratio. The win ratio interpretation does not extend to engagements with more than one Red target because the numerator, which represents expected Red losses, would need some sort of transformation to make it an estimate of the probability of Red being defeated (see Footnote 4). The more appropriate interpretation is that Table VIII score is a hit expectation ratio that represents both hits and survival.

M1 single tank performance standards are subjectively set on Table VIII using the hit expectation ratio concept. Five to one, for example, is the minimum acceptable hit expectation ratio for defensive engagements. It is based on traditional assumptions for force ratios (i.e., Blue may be expected to be outnumbered five to one in the defense). Hit ratio is converted to a 0 to 100 point scale such that 70 points on an engagement represents the minimum acceptable hit expectation ratio. (This conversion is more fully described below under Complications in Gunnery Testing.)

The hit expectation ratio must be interpreted with caution. The ratio applies only to engagements of a given force ratio (either one Red engaging one Blue or two Reds engaging one Blue). It cannot be generalized to larger force ratios. Consider the difference between a one-on-one engagement and a two-on-one engagement. For a given first target hit time, the Blue chances of surviving to hit the first target are lower when two targets are (theoretically) shooting at Blue than when there is only one Red target. Thus, based on the first target performance, Expected (Blue Hits) is lower, Expected (Red Hits) is higher, and consequently, hit expectation ratio is lower for a two-target engagement than for a one-target engagement. In the two-target engagement, Blue also has a chance to hit another target which can increase the Expected (Blue Hits), but Expected (Red Hits) also increases and at a much higher gradient. Consequently, for any given time to hit the first target, the hit expectation ratio is smaller in a two-target engagement than in a one-target engagement. Similarly, as more targets are added to an engagement, the hit expectation ratio will be lower. That a Blue tank can perform at a five to one hit expectation ratio for two-on-one engagements does not mean that it could survive a five-on-one engagement, nor does it indicate

that Blue could sustain a five to one hit expectation ratio for engagements with more than two targets. The hit expectation ratio from Table VIII implies very little about a Blue unit's ability to defeat numerically superior forces, unless they can be engaged only two at a time.

One last point is that the calculation of cumulative hit probability for two target engagements assumes that the first target to be hit is the most dangerous target. When a crew hits the least dangerous target first, an arbitrary penalty is assessed against their score. There is nothing in the method that would have prevented directly estimating the hit expectation ratio that would result if the least dangerous target were hit first.

To recap, there are five significant points regarding Table VIII threat-based scoring and standards:

1. The force ratios depicted are primarily two to one (if troop targets in an engagement are counted as one target).

2. The performance metric is the hit expectation ratio per engagement based on time for hitting each target. It is rescaled such that 70 points represents the minimum acceptable hit expectation ratio.

3. Estimates of the metric are mathematical derivations of cumulative hit probabilities based on when each target is hit. Blue hits on Reds are conditioned on the probabilities of Blue survival.

4. Cumulative hit probabilities are derived from one-sided modeling. Probabilities assume targets are hit in order of threat magnitude. Hitting targets out of order of threat magnitude is scored by deducting penalty cuts from the hit expectation ratio-based score.

5. Minimum standards for Blue performance are set by engagement based on traditional assumptions about force ratios in the offense and defense.

Revised Table XII

Recently, the Armor School's Directorate of Training and Doctrine (DOTD) proposed a threat-based Table XII. The proposed Table XII is a platoon gunnery exercise with dynamic portrayal of advancing targets for Blue defensive engagements. Targets are sequentially presented in an advancing array across successive, closer range bands that portray the threat advancing in time. Targets that are hit in one range band do not appear in subsequent bands.

There are a number of differences in the methodology for deriving scores for Table XII compared to Table VIII--differences which are independent of the change from crew to platoon level of analysis. These differences introduce an additional perspective on the scoring and standard setting problem. First, as originally proposed, target arrays for the new Table XII are representative of either a scout unit with two BRDMs and two groups of troops or a threat company with 10 vehicles (tanks and BMPs). Thus, force ratios are either one to one (again arbitrarily counting each group of troops as one target) or two-and-a-half to one. For the threat company engagements, other array sizes,

ranging from 8 to 14 vehicles, are under consideration. Threat doctrine, platoon capabilities, and limited training resources are all influencing the deliberations.

The second difference between the proposed Table XII and Table VIII is the performance scoring metric. For the proposed Table XII, that metric is hit ratio for each engagement. That is, threat expected hits will be calculated within each range band based on Red capability and Blue exposure time and then summed across bands. Red capability is reduced by the number of Red targets hit. However, within an array no distinctions are made as to the type of target hit. This means that hitting targets in order of threat magnitude of the individual targets (if they differ) apparently will be ignored. Blue hits will simply be counted and the ratio of Blue hits to Red expected hits computed. Although hit ratio is not the same as the Table VIII hit expectation ratio, it still suffers the same problem of generalizing to other engagements. That is, expected hits from 14 Red vehicles would not be the same as expected hits from 10 Red vehicles, other things being equal. Thus, hit ratio calculated for a 10-on-4 engagement would not be the same as that calculated for a 14-on-4 engagement given equal numbers of Red targets hit by the Blue.

The third difference is that estimates of Red capability on Table XII are based on Red hit rate calculated as the product of firing rate and hit probability. This is in contrast to the cumulative hit probability basis for Table VIII. Cumulative hit probability calculations assume an identifiable start point (time zero). For the first seconds after that start point, the probability of firing a round in order to achieve a hit is negligible. In later time intervals (after the target is acquired, aimed at, etc.), the probability of firing a round and achieving a hit increases. (See Figure 11, p. 44.) The hit rate based metric assumes that identification of a time-zero start point is less certain. It further assumes that as soon as a Blue vehicle is exposed it has just as much chance of being hit as in any other time interval in which it is exposed. Given assumptions about the continuing and chaotic nature of the future battlefield, this may not be an inappropriate simplification. In addition, the hit rate formulation assumes that multiple Red vehicles (of the same type) simply multiply the effects of a single vehicle. That is, if one vehicle can hit four targets a minute (one every 15 seconds), two vehicles can hit eight targets a minute (one every 7 1/2 seconds). Use of hit rate and the multiplier effect are the two key ingredients in the Lanchester-type equations used in combat modeling.

Despite the differences between Table VIII and the proposed Table XII, there are two important similarities. For one, like Table VIII, calculations for Red capability are made from one-sided modeling. That is, Blue capacity to hit Red targets is used in constructing this scoring system. Finally, minimum standards for performance for Table XII are based on Table VIII standards. That is, Table VIII specifies a minimum standard for defensive engagements of five to one using traditional assumptions about overall force ratios. That same ratio is proposed for Table XII defensive engagements.

Thus, Table XII scoring methodology is described by the following:

1. The force ratios depicted are primarily one to one and two-and-a-half to one.

2. The performance metric is hit ratio per engagement based on the range bands in which targets are hit.

3. Estimates of the metric are based on mathematical derivations of hit rate which are based on when each target is hit. Blue hits on Red are simply counted.

4. Hit rate is derived from a one-sided calculation. Either targets within arrays are all the same type or the differences in magnitude of threat capabilities are ignored in calculating Red capability.

5. Minimum standards for Blue performance are based on Table VIII which in turn is based on traditional assumptions about force ratios in the offense and defense.

Engagement Development Process

TRAC-WSMR Engagement Development Process

Another recent effort to develop a threat-based scoring system has been that of LaFerriere, Chiefo, and Watson (1987) from the U.S. Army TRADOC Analysis Command-White Sands (TRAC-WSMR). Their objective was to develop threat-based target arrays in response to a request from the Seventh Army Training Command, Grafenwoehr, FRG. LaFerriere et al. used an elaborate procedure of computer modeling to identify target arrays and to determine Red capabilities from which to judge Blue performance. Their efforts began with a computer model (CARMONETTE/T) of an offensive scenario and a defensive scenario. The defensive scenario pitted a Blue battalion-sized task force against a Red tank regiment. The offensive scenario pitted a Blue battalion-sized task force against a Red tank company. Offensive confrontations and defensive confrontations were simulated 40 times each. The output from each run of the simulation gave a battle history indicating who shot at whom, when, where, and with what consequence. These histories were then partitioned into discrete offensive and defensive engagements for tank platoons and tank sections.

The effort to systematically identify threat-based target arrays through computer simulations appeared to give well-founded estimates of appropriate force ratios. However, there were several subjective decisions, external to the computer model itself, that dramatically affected the results. First was the decision to model battalion on regiment in the defense and battalion on company in the offense. Obviously, different initial force ratios would alter battle histories and the resulting engagements. Second was the input of Blue capabilities required for the force-on-force modeling. Different estimates would also alter the battle histories and resulting engagements. Third, the battalion histories were partitioned into discrete engagements by searching for periods in which no exchange of fire occurred. The length of the period was adjusted so that the number of targets in any one engagement was neither too large nor too small, where "too large" and "too small" appear to be made as subjective judgments. Finally, engagements were analyzed to determine Blue probability of survival. Those engagements that require Blue performance for survival to exceed a subjectively set limit were eliminated from further consideration.

Resulting force ratios of the engagements produced by LaFerriere et al. (1987) vary across the final set of engagements. For defensive engagements, the ratios vary from an extreme of 16 Red on 4 Blue (four to one) to a low of three Red on two Blue (one-and-a-half to one). For the offensive engagements, ratios vary from six Red on four Blue (one-and-a-half to one) to one Red against two Blue (one-on-two). In each case, the decisions made by LaFerriere et al. may be "reasonable," which is just the point. The modeling itself and the treatment of the modeling output depend heavily on "reasonable" judgments, a characteristic shared by the selection of force ratios for Table VIII and Table XII.

Like Table VIII, derivation of survival probabilities for each engagement is based on a modeling of cumulative hit probabilities rather than a simple calculation of hit rate. Unlike Table VIII, the modeling is two-sided. After engagements were determined, they were modeled again (by a separate program) to determine when all Red vehicles were hit or when half of the Blue vehicles were hit, whichever came first. Results of the simulated offensive and defensive engagements (1000 for each different type of engagement) were recorded to produce a distribution that indicates the probability that a Blue platoon or section would still be above 50% strength for any given elapsed time. That distribution for probabilities of survival is used in measuring a platoon's or section's performance. Thus, Blue observed performance is compared to the distribution of outcomes to determine a probability of survival for that level of performance. Score interpretation must be made in light of the Blue capabilities that were entered into the model when the probability distributions were obtained. That distribution depends on the level of expected Blue performance used in the simulation. Higher levels of expected Blue capability would result in higher probability of survival values for any given level of observed performance. Thus, Blue observed performance is compared to both Red capability and expected Blue capability. In contrast, in Tables VIII and XII, Blue observed performance is compared only to Red estimated capabilities to derive performance scores.[5]

Finally, minimum standards of performance were arbitrarily set by LaFerriere et al. (1987). Their recommendation is that the Blue platoon or section should hit targets fast enough to achieve a 50% survival probability. Considering the size of the target arrays and the survival criterion (half of the Blues remaining), the 50% survival probability implies hit ratios ranging from a high of eight Blue hits to one expected Red hit (for the four-on-one force ratio engagements) to a low of one Blue hit to one expected Red hit (for the one-on-two force ratio engagements).

Interestingly, while TRAC-WSMR's modeling is certainly more sophisticated than either Table VIII or the proposed Table XII, their recommended scoring procedure is much simpler. Engagement scores are based only on the time required to hit the last target in an array or until time runs out, whichever comes first. Times for hitting other targets in the

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[5]This is overstated to some extent. Assumed Blue position (moving, stationary, hull defilade, etc.) is used to assign Red hit probabilities in Tables VIII and XII. However, Blue firing rates and hit probabilities (the primary variables influenced by crew performance) are not used.

arrays are not recorded. Thus, hitting initial targets quickly and thereby reducing threat capabilities, or hitting most dangerous targets first do not influence the TRAC-WSMR score.

In contrast to Table VIII and the DOTD proposed Table XII methodologies, the LaFerriere et al. (1987) approach includes the following features:

1. The force ratios depicted range from four Red to one Blue to one Red on two Blue.

2. The performance metric is probability of survival based on time for hitting the last target or until time runs out, whichever comes first.

3. Estimates of the metric are derived from iterative computer modeling.

4. Survival is derived from iterative two-sided computer modeling. Scoring ignores differences in the order of target hits (i.e., hitting most dangerous targets first) and times for hitting targets other than the last target in an array.

5. Minimum standards for Blue performance are 50% probability of survival.

Speed and Accuracy Scoring Requirements for Gunnery Research

In the previous chapter, hit rate was described as a rather simple metric for scoring speed and accuracy as a composite outcome measure for gunnery. In the previous section of this chapter, three more elaborate approaches have been described. These approaches include threat capabilities with implications for the survival aspect of gunnery, and they build performance standards into the process of performance scoring. In this section, we need to explore these options in terms of the research requirements for testing gunnery proficiency. We will begin with a discussion of some basic issues and requirements for a proficiency metric and follow with a discussion of some of the complicating issues pertaining to gunnery testing. Finally, we will review our options.

Basic Gunnery Scoring Requirements

There are several basic issues that can easily get lost during the untangling of complexities of gunnery scoring. The first concerns a basic understanding of what we are trying to measure.

Observed performance score versus crew and platoon proficiency. In a previous report in this series, Campbell and Hoffman (1990) made a distinction between proficiency and observed performance. They used the term *proficiency* to refer to a crew (or platoon) skills construct that underlies *observed performance*. Thus, proficiency is assessed only indirectly through observed performance. While observed performance may be erratic (Hoffman, 1989) as a skills construct, one must view underlying proficiency as relatively stable. Performance, therefore, is not a perfect index of proficiency, but it is subject to trial-to-trial variations and to a lack of precision and contamination in testing and measurement procedures. The imperfect

association of proficiency and performance will limit actual correlations between performance on different engagements, but conceptually the association between engagements holds. Furthermore, proficiency is the ultimate criterion variable for training research with index of observed performance the only available surrogate. This basic premise has some important implications for gunnery scores that are couched in terms of Red capabilities. These will be explored further below.

Performance scoring versus standard setting. The distinction between scoring performance and setting standards, made in a previous chapter, bears repeating. Constructing a performance score and setting performance standards are separate issues. Using Table VIII scoring as an example, one can distinguish between the calculation of hit expectation ratios and the translations of these ratios into Table VIII scores. Table VIII hit expectation ratios are metrics without any performance standards attached. That is, hit expectation ratio gives an index of performance that does not, by itself, indicate acceptable and unacceptable performance. Performance standards for Table VIII were set through a translation process that sets three cutoff points. First, the hit expectation ratio that is regarded as passing is selected (e.g., five to one for the defensive engagements or three to one for offensive engagements against single target or simultaneous targets). This ratio is equated to 70 points, the minimum passing score. Second, the minimum hit expectation ratio that will be assigned 100 (the maximum) points is selected. Performance at or above that hit expectation ratio will yield 100 points. Third, the hit expectation ratio required to receive any points at all is selected. Hit expectation ratios at or below that level receive zero points (e.g., any performance that results in a hit expectation ratio of 1 or less receives zero points). Scores between these points are calculated by linear interpolation. The result is a function such as that illustrated in Figure 9 which gives a non-linear translation of hit expectation ratio into performance points. Each type of engagement (offense, defense, moving target, stationary target, etc.) has a different function relating hit expectation ratio to Table VIII points. This translation of hit expectation ratios is unnecessary for proficiency testing *per se* and, as illustrated in Figure 9, may even distort the measurement scale.

Test versus test item. A typical paper-and-pencil knowledge test is composed of a number of test items that sample the intended test domain. From the traditional psychometric perspective, individual item scores are important only to the extent that (a) they are judged to be within the domain covered by the test and (b) they contribute variance to the overall test score. Separately, the individual items are viewed as fallible indices of proficiency; only the sum, or average, of the test items is accepted as reliable. Individual items are important only to the extent that they contribute to the total test. Hands-on tests of motor skills or procedures (e.g., put on a field or pressure dressing, disassemble an M240 machinegun) are also composed of test "items." In this case the items are not samples of the domain, rather they are the steps in the procedure. Again, for judging overall proficiency, any individual step is significant only to the extent that it affects the overall test score. In both knowledge and performance testing, distinctions between test items and the test as a whole is straightforward. Furthermore, estimation of knowledge or skill proficiency is made from the test as a whole, not any individual item.

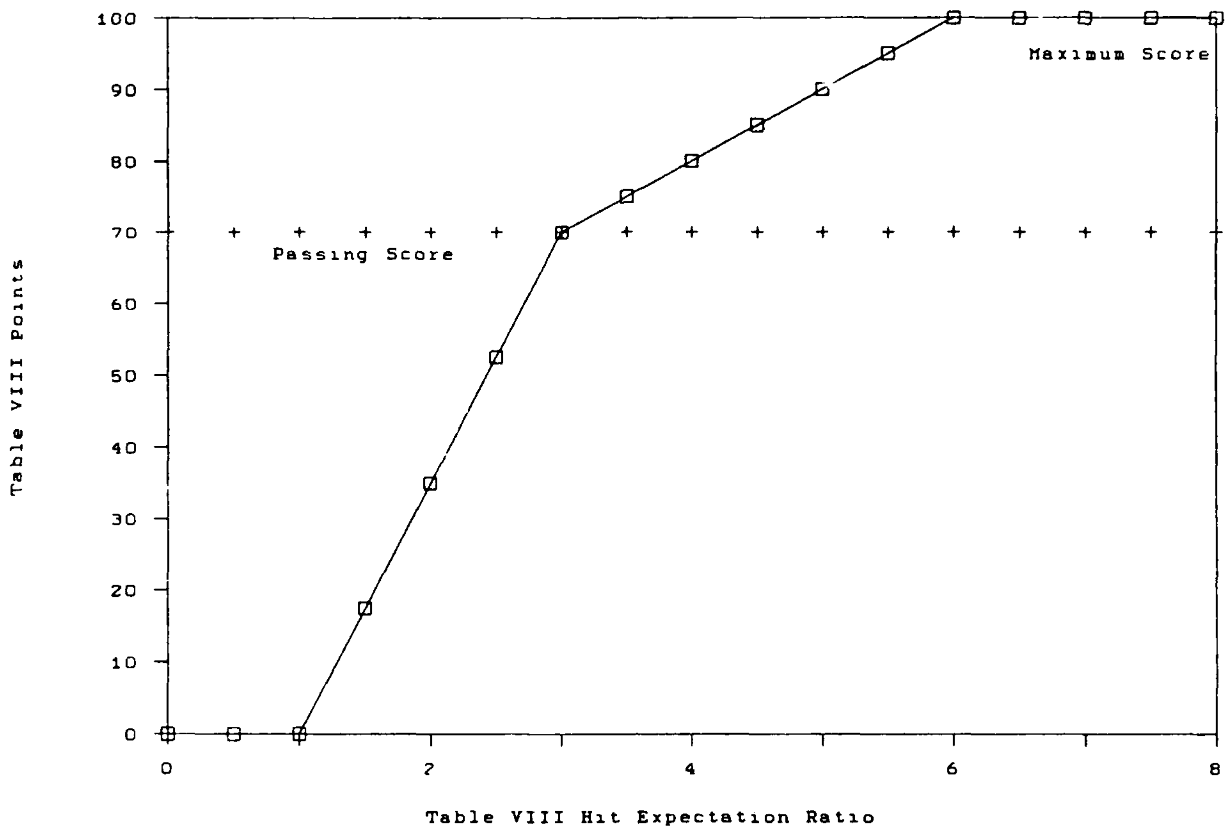

Figure 9. Example translation of Table VIII hit expectation ratio into Table VIII points.

Complications in Gunnery Testing

In Table VIII, each engagement is termed a "task," and performance standards are set for each of these tasks. This terminology and procedure suggests that each engagement is a test and as such a separate estimate of proficiency. Thus, engagements in Table VIII are given more significance than typical test items. They appear to be treated as more than just samples of gunnery proficiency.

Items and test standards. The process of setting performance standards for each engagement and scoring each engagement in terms of those standards creates some interpretation problems for gunnery proficiency as a whole. Scores from Table VIII, as well as the proposed Table XII and the TRAC-WSMR approaches, are as much a function of threat capabilities as they are a function of Blue proficiency. Because scores are expressed in relation to

estimated threat capabilities, scores for different engagements are not easily compared. If different engagements present target arrays representing different numbers, types, and ranges of Red vehicles, then scores differ solely because the threat is different. Setting standards for each engagement results in setting *multiple proficiency* standards. That is, because the same passing score is required, the proficiency necessary for passing "easy" engagements (e.g., two BMPs) is lower than the proficiency required for passing "hard" engagements (e.g., two T-80 tanks), other things being equal. Thus, minimum performance standards for one engagement imply little about performance standards for other engagements, and the meaning of the performance standard concept is less robust than might be desired.

For the moment, we will refer to these differences among engagement conditions as differences in engagement difficulty. Certainly, items on a standard knowledge test differ in difficulty in the sense that the average score varies from item to item. However, on a typical test, standards are not set on individual items. With its emphasis on setting standards for each engagement, the issue of difficulty is more significant for gunnery testing.

While threat-based scoring metrics may be useful outcome measures for analyses of gunnery tactics, they are contaminated for use in training research which is focused on Blue behavior. A performance score that is free of this difficulty factor would be advantageous for training research. Roscoe (1971) argues very clearly that the amount of transfer depends on proficiency level attained on a training device. Given that performance is a negatively accelerating function of learning (i.e., performance increases with practice, but the amount of change between trials decreases), transfer during early learning is expected to be greater than transfer during later learning. If engagement scores are confounded with threat capabilities, the mean differences in performance scores do not necessarily equate to differences in proficiency, and interpretation of engagement transfer data is muddied. On the other hand, if engagement scores can be anchored to proficiency alone, interpretation of transfer data is more straightforward. However, as discussed below, there are some hidden trade-offs, and engagement level scoring is influenced by more than just the threat.

<u>Influences on engagement difficulty and threat-based performance scores</u>. So far in the discussion, three variables that affect scores in a threat-based scoring system have been discussed. They are (a) Blue proficiency, (b) Blue equipment capabilities, and (c) Red capabilities. Blue equipment further decomposes into two factors. One factor is that there are different modes of operating the tank (e.g., main gun precision, main gun degraded) that require different procedures. Thus, proficiency is multidimensional consisting of skills related to multiple performance procedures. The second factor is that within operating modes, equipment capabilities place limits on performance as scored by threat-based metrics. For example, on the threat side of the scoring computation, Blue vehicle type (particularly the size of the Blue vehicle) affects Red estimated hit probability also. On the Blue side, fire control system accuracy limits Blue hit probability. For training research, only Blue proficiency and Blue performance procedures are of interest. Blue equipment capabilities and Red capabilities are confounds that influence engagement score means apart from crew proficiency.

These variables that influence threat-based scores are mixed in a variety of ways. For example, differences between engagements in number and type of targets (e.g., T-64 tank versus T-80 tank) change only threat capability (T-64 tanks presumably have lower hit probabilities), while Blue performance procedures remain the same. In this case, differences in threat-based engagement scores would occur which have nothing to do with Blue proficiency *per se*. Thus, one would expect threat-based scores to show mean differences in scores on the engagements, but moderate correlations (limited by trial-to-trial inconsistency) between engagements. On the other hand, mean speed and accuracy scores *without reference to the threat* would be expected to be relatively constant across the different engagements.

Differences in system malfunctions may affect performance procedures while the threat may remain constant. For this example (assuming a constant threat), we may expect mean differences in scores because degraded mode techniques are more cumbersome and less accurate than normal mode (Black & Kraemer, 1981). In addition, to the extent that degraded mode performance procedures are unique from normal mode requirements, correlations of performance scores between different engagements may be low. These differences would occur whether or not speed and accuracy were expressed in relation to the threat.

Target attributes can potentially affect a threat-based scoring system. For example, there may be differences in types of targets (e.g., tanks versus troops) that change both performance procedures (i.e., main gun engagement versus COAX engagement) and Red capabilities. In this case, part of the difference in threat-based scores are presumably related partly to threat differences and partly to Blue requirement differences. Another example concerns changes in target range. At greater distances, other things being equal, targets are harder for the Blue to hit, but also Red capabilities are reduced. This creates a trade-off for threat-based scoring, the results of which are not readily discernable.

In addition to the above conditions, Blue mission has two effects on observed performance scores. The first is related to timing procedures. In existing Tank Tables, time starts for offensive missions when the targets appear. For defensive missions, time starts when the Blue tank moves from turret defilade to hull defilade. Thus, for defensive engagements only, acquiring targets, issuing fire commands, setting switches, and making initial target lay all occur before time starts. The second factor is related to estimated threat capabilities. Blue exposure differs between the two types of engagements. For offensive engagements compared to defensive engagements, Blue is moving, which presumably decreases Red's estimated probability of hitting Blue. On the other hand, Blue is also fully exposed, which presumably increases Red's hit probability. Again, the trade-off acts to obscure proficiency estimation.

As a result of the interplay between Blue performance procedures and Red capabilities, interpretation of threat-based scores can be confusing. The guiding principle for selecting a metric for training research is to obtain an outcome score that reflects crew or platoon activities as directly as possible by being as closely associated with relevant crew/platoon behaviors as possible. Factors that influence obtained scores but that crews/platoons cannot control confound scoring for training research, particularly if standards are set on an engagement-by-engagement basis.

Threat magnitude and order of target hits. Another complicating issue is that survival as well as hits is an important outcome of gunnery. Certainly survival is related to hits but not perfectly. While the precise capabilities of threat targets cannot be controlled by crews or platoons, gunnery doctrine indicates that targets should be engaged in order of threat magnitude to minimize exposure to the most dangerous of those targets. Interestingly, while Table VIII scoring could directly address target order, it does not. That is, scoring tables could specify which target is hit first. Instead, Table VIII scoring assumes that the first target hit is the most dangerous target and computes hit expectation ratio accordingly. Failure to hit the most dangerous target first is accounted for by assessing penalty points after the fact. The TRAC-WSMR proposal also fails to include order of target hits in its scoring system. The proposed Table XII incorporates scoring the order of target hits but only between range bands. Vehicle representations that are hit in one range band do not appear and therefore do not contribute to Red capabilities in subsequent range bands. However, within a range band, no distinction is made with regard to threat magnitude of targets.

Implications for Selecting a Gunnery Metric

A number of complicating issues for scoring gunnery have been presented. The cumulative impact seems to be that observed performance at the engagement level is intertwined with a variety of effects and conditions that influence that performance. A gunnery metric that is influenced only by crew or platoon proficiency, that includes an evaluation of target hits in order of threat magnitude, and that is directly comparable among engagements is not possible. Gunnery scores that include an indication of survivability must input some amount of information concerning the target array; survival is threat dependent as well as Blue dependent. In addition, there are other situational conditions that interfere with direct interpretation of engagement scores. These vary from the obvious offense versus defense and mode of operation differences previously mentioned to more subtle differences in weather (visibility), vegetation (effectiveness of target camouflage), and width of the range fan (amount of area to search). The problem of gunnery metrics being influenced by engagement conditions cannot be circumvented. This leads to the conclusion that less emphasis should be given to engagement scores and more on total test scores in training research.

Rather than focus scoring and standard setting on individual engagements, emphasis needs to be on (a) sampling various engagement conditions (Campbell & Hoffman, 1990), (b) aggregating engagement scores into a total score, and (c) interpreting *relative* proficiency from a normative comparison of scores across the different types of engagements. Furthermore, engagement scores do not have to be tied to performance standards for interpreting training research results. To avoid setting standards that are disconnected from crew or platoon proficiency, standard setting processes need to explicitly include consideration of engagement sampling issues, the difference in operating modes (e.g., precision versus degraded), and other situational constraints that influence threat-based survival scores.

In the next section, target hit scoring will be further developed. The major shift in emphasis is away from direct interpretation of engagement scores (i.e., pass/fail based on estimated engagement survival). Crew and platoon scoring are discussed. The last section in the chapter presents an approach to setting gunnery performance standards.

An Approach to Measuring Target Hit Performance

The purpose of an outcome measure of gunnery is to provide a convenient way to summarize overall gunnery proficiency. In order for such a measure to include all of the aspects of the gunnery domain that have been alluded to in this and preceding chapters, the measure must summarize performance across a sample of engagement conditions. The issue of sampling has been covered in a previous report (Campbell & Hoffman, 1990), however some additional information is presented below. Of primary concern is the specification of a scoring strategy given that no requirements, implicit or explicit, are made about the comparability among engagements selected for a test.

Of the options for scoring methods reviewed, scoring Blue performance based on the calculations of threat cumulative hit probabilities provides the most complete information. Target selection as well as speed and accuracy of firing is also indicated. The proposed Table XII method includes target selection only for dynamic target arrays that depict a series of sequentially related targets. The calculation of cumulative hit probabilities and the transformation of those probabilities into hit expectation ratios can be used for static or dynamic engagements.

Rejection of Hit Rate as a Performance Metric

Implicit in the above paragraph is a rejection of earlier suggestions (Hoffman, 1989; Hoffman & Witmer, 1989) to use hit rate as the metric of gunnery performance. This was done for two reasons. First, in essence, hit rate summarizes hit times across all targets regardless of their threat. As a result, it fails to capture any information concerning order of target hits. The problem can be overcome, as indicated by a recent scoring scheme developed by DOTD, by weighting targets in calculating hit rate (Major Spears, Directorate of Training and Doctrine, U.S. Army Armor Center and School, personal communication, January, 1990). However, the result remains a linear combination of target hit times. The cumulative hit expectation ratio model indicates that a linear combination model is not appropriate. First, for each target, hit rate is a linear function of time such that the function is the same anywhere along the time scale. This is contrary to the doctrinal notion that quick opening times are essential and is inconsistent with the hit expectation ratio concept where delays in firing are much more costly early in the engagement compared to later in the engagement.

The second reason for rejecting hit rate is that performance on each target contributes independently to the engagement score. However, the hit expectation ratio concept shows that there is a dependency between time to hit the first target and change in hit expectation ratio in relation to subsequent target hits. That is, the relationship between time to hit subsequent targets and performance score depends on when the first target is hit. The lower the first target hit times, the faster the hit expectation ratio changes for a

given change in subsequent target hit time (see Figure 10). Thus, hit rate has been rejected because in its basic form it contains no target threat information, and when it is modified to contain such information, it does so less completely than hit expectation ratio.

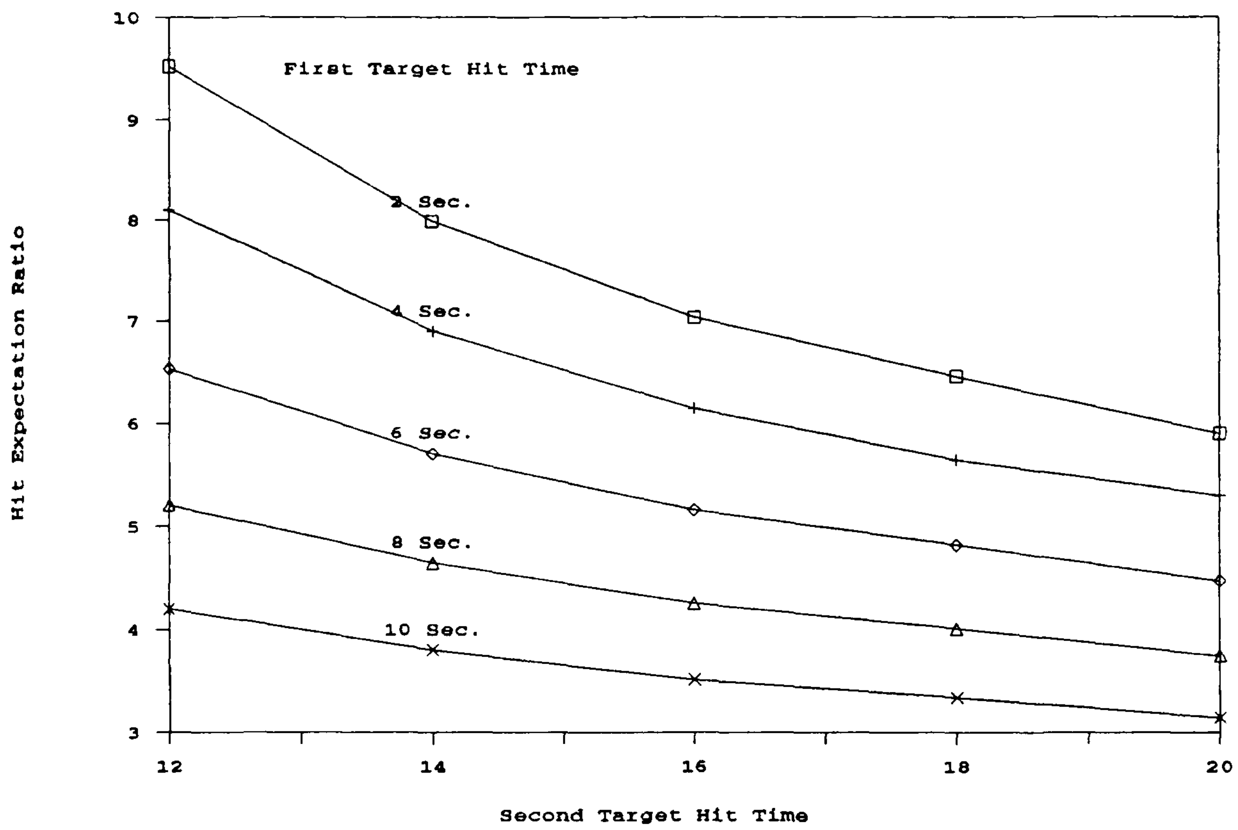

Figure 10. Relationship between hit expectation and second target hit time as a function of first target hit time.

Hit Expectation Ratio

Hit expectation ratio expresses the speed and accuracy of Blue hit performance in such a way as to capture the criterion concepts for hitting and surviving, including the doctrine of hitting targets in order of threat magnitude. Admittedly, it is dependent on engagement conditions which render direct comparisons of proficiency across different engagements meaningless. On the other hand, within engagements it orders crews in a way that best matches our concept of gunnery proficiency.

Two alterations to the Table VIII methodology need to be made to increase its usability in training research. First, the current Table VIII methodology handles only two targets. Calculation of hit expectation ratios

for three or more targets is desirable given the target rich environment described by Doyle's (1990) threat analysis. Second, Table VIII calculates points by first assuming that the first target hit is always the most dangerous and subsequently invoking a standard penalty when crews fail to do so. That standard penalty may over- or under-represent the severity of the error. Hit expectation ratios can and should be calculated directly for the exact order of target hits. For crew level gunnery the solution involves a relatively straightforward extension of Table VIII one-on-two calculations to one-on-n calculations. For platoon level, the solution is more complex.

Crew Scoring

The Table VIII hit expectation ratio concept includes information about Blue speed and accuracy based on observed Blue hits on Red. It also includes information about Blue survival based on estimates of Red hits on Blue for the time of Blue exposure.

The revised algorithm follows the same logic but takes a slightly different mathematical form than described in the anonymous paper entitled Tank Table VIII Scoring Methodology (U.S. Army Armor and Engineer Board, 1984). The difference essentially lies in the order of calculation. The revised procedure is more conducive to extensions of the one-on-n situation. One may use the revised algorithm to derive explicit formulas for one-on-one and one-on-two engagements. The results, however, are identical to those used in the current Table VIII methodology.

The 1-on-n algorithm. Suppose there are *n* targets and that they are hit at times t_1, t_2, ..., t_n, respectively. Therefore,

Let t_i = time to hit target Red_i where i = 1, 2, ..., up to the number of Red targets.

Let t_e = total time of exposure. For any Red_i that is not hit, let $t_i = t_e$.

If all targets are hit, then t_e = maximum t_i.

The first step in the algorithm is to look up the probabilities that Blue survives each target, independently, and calculate the joint probabilities of Blue surviving all targets. This involves calculating the probabilities of Blue surviving to each of the times that Blue is observed to hit a target and to the termination of the engagement, if not all targets are hit:

$P(H_{RiTj})$ = probability that Blue is hit by Red_i by t_j, from the cumulative hit probability curves for each type of target.

$P(S_{RiTj})$ = probability that Blue survives Red_i to $t_j = 1 - P(H_{RiTj})$. (4)

$P(S_{Tj})$ = probability that Blue survives all Red targets to t_j

= [$P(S_{R1T1})$, if R_1 is hit before t_j, or PS_{R1Tj}, otherwise] *
[$P(S_{R2T2})$, if R_2 is hit before t_j, or PS_{R2Tj}, otherwise] *
....
$P(S_{RiTi})$, if R_i is hit before t_e, or PS_{RiTj}, otherwise], (5)

where there is a term for each target such that i iterates from 1 to the total number of targets (i), and j iterates from 1 to e.

Example 1: Probability that Blue survives to t_2 when there are three targets which are hit in the order Red_1, Red_2, Red_3:

$$P(S_{T2}) = P(S_{R1T1}) * P(S_{R2T2}) * P(S_{R3T2}). \tag{6}$$

$P(S_{T2})$ equals the probability that Blue would have survived long enough to hit Red_2.

Example 2: Probability that Blue survives to the end of the engagement, t_e, when there are three targets and Red_1 and Red_3 are hit but Red_2 is not hit:

$$P(S_{Te}) = P(S_{R1T1}) * P(S_{R2Te}) * P(S_{R3T3}). \tag{7}$$

A $P(S_{Tj})$ is computed for each target hit time and for the termination of the engagement because not all targets are hit.

Next, expected Blue hits on Red are estimated by weighting the probability that Blue would have survived long enough to have hit each Red by an indicator of whether or not the Red was hit:

Probability that Red_i could have been hit by Blue by t_i =

$$P(L_{Ri}) = P(S_{Ti}) * H_i \text{ , where } H_i = 1 \text{ if Blue was observed to hit } Red_i\text{; otherwise } H_i = 0. \tag{8}$$

These probabilities are summed to give:

$$E \text{ (Red loss)} = E \text{ Blue hits} = P(L_{R1}) + P(L_{R2}) + P(L_{Rj}). \tag{9}$$

Again, this number represents Blue observed hits discounted for the probability that Blue would not have survived long enough to have hit the Red had they been shooting back.

The probability of Blue being hit by t_e is also computed as 1 - PS_{Te}, where PS_{Te} equals the probability of Blue survival until the end of the engagement. In the logic of the hit expectation ratio, 1 - $P(S_{Te})$ is the probability that Blue is hit, Expected (Blue loss), or Expected (Red hit). (See Figure 8, p. 27.) While the probability of Blue survival also equals the probability that Blue would not lose, it does not equal the probability that Blue would win. That is, Blue could survive a given engagement, with some level of probability, by limited exposure without hitting any targets.

Finally, the hit expectation ratio is computed:

$$\frac{E \text{ (Blue hits)}}{E \text{ (Red hits)}} = \frac{P(L_{R1T1}) + P(L_{R2T2}) + \ldots + P(L_{RiTi})}{1 - P(S_{Te})} \tag{10}$$

Again, this ratio can be understood as a hit expectation ratio, a loss expectation ratio or as a performance ratio that indicates Blue's ability to hit and survive to hit again (see Figure 8).

Computation examples. A spreadsheet is presented in Appendix A that allows scoring of single Blue tank (Table VIII) engagements with up to five threat targets. Fewer numbers of targets may also be scored by entering zeros under target hit times. The routine directly accounts for target order and missed targets. Crew performance is scored by simply entering the times observed to hit each target, with 999 entered for targets that are not hit. New engagements (tasks) can be programmed by changing target titles and entering new cumulative hit probability data in a data matrix that appears near the bottom of the spreadsheet. The program is sufficiently flexible to allow part of the threat targets to appear sometime after the start of the engagement.

Appendix A presents a detailed explanation of the operation of the scoring algorithm. At this point, however, three example scoring problems are presented below to illustrate how the methodology works. The examples are all for the same hypothetical task. In the sample task, Targets 1 and 2 are Main Battle Tanks (MBT) and Targets 3, 4, and 5 are infantry vehicles (BMP). Targets 1, 3, and 4 appear initially; target 2 appears 10 seconds later; and target 5 appears another 10 seconds after that. Calculations are based on threat cumulative hit probability distributions that are strictly notional. These distributions are presented in Figure 11 below.

These data are used to calculate expected Blue hits on Red and to calculate expected Red hits on Blue. To emphasize the fact that Blue performance is being measured, the expected Blue loss interpretation is used instead of expected Red hits on Blue. Expected Blue hits divided by expected Blue loss yields hit expectation ratio; however, for presentation, we have chosen to rename it performance ratio. Our motive for a name change is because hit expectation ratio is such a difficult concept and has tended to evoke inappropriate reactions. In reality, it provides little hit exchange information in any broad or absolute sense. It tells little, if anything, about a crew's ability to defeat the threat under any conditions other than the exact conditions of the particular engagement for which it is calculated. The hit expectation ratio concept, however, remains a useful way to score speed, accuracy, and hitting targets in order of threat magnitude in a measure of gunnery proficiency. Because of the tendency to overinterpret hit expectation ratio, we have decided to avoid the terminology in the spreadsheet and use the more neutral phrase "performance ratio."

The spreadsheet also calculates Table VIII score. In order to convert performance ratio data into a score, conversion values must be added to the data base. Three points are needed, according to the current Table VIII system: (a) the performance ratio needed to gain any points (i.e., performance at or below that performance ratio yield no points), (b) the minimum passing performance ratio, and (c) the performance ratio at which a maximum score of 100 points will be awarded. Figure 9 (p. 35) illustrates a sample function to convert performance ratios to points for the following examples where the three break points are 1, 3, and 6. These values are for illustration only; they *do not* imply any endorsement for particular performance standards. The inclusion of this routine in the spreadsheet is

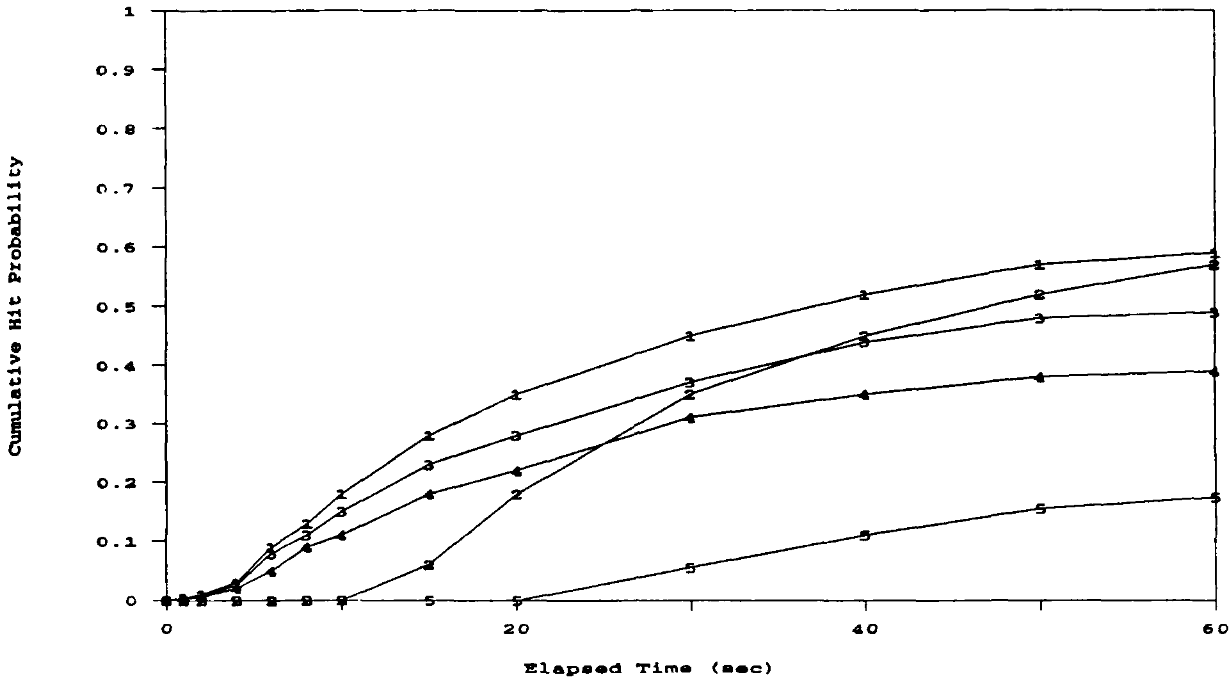

Figure 11. Notional threat cumulative hit probabilities.

not an endorsement of Table VIII score as a useful research metric. For research purposes performance ratio should be used.

Several scoring examples are presented below to illustrate the operation of the scoring program. Figures presented for each example show the spreadsheet control panel that presents inputs and outcomes related to scoring a crew's performance.

The first two scoring examples were selected to illustrate that the performance ratio is dependent on expected Red losses (i.e., Blue hits) and expected Blue losses (e.g., Blue survival) and that there is not a one-to-one correspondence between expected Red losses and expected Blue losses. Thus, in Example 1 (Figure 12), *E* (Blue Loss) is .66 and *E* (Red Loss) is 2.71 for a performance ratio of 4.08. In Example 2 (Figure 13), some target times are slower, some are faster, and Red 5 is missed. However, the *E* (Blue Loss) is essentially the same as for Example 1 (.67), but *E* (Red Loss) is lower (2.58). As a result the performance ratio is lower (3.86).

The next two examples illustrate the effects of target order. In Example 3 (Figure 14), target times are the same as for Example 1 except that the order of target hits is scrambled to a less optimum pattern. Consequently, the performance ratio for Example 3 (3.32) is lower than for Example 1 (4.08). Example 4 (Figure 15) is presented to illustrate the significance of target order decisions when targets do not all appear at the same time. Times for Example 4 are identical to times for Example 1 except that times for the second and third Red vehicles are switched. In the first

```
     A      B           C          D          E          F         G      H
 1 TABLE VIII  Extended 1-on-N     |Human Resources Research Organization
 2             Methodology (n = 5) |-------------------------------------
 3 EXAMPLE 1; CRITERION = 1,4,6    |ATTN: Gene Hoffman or Ric Blacksten
 4 Instructions at A100..A141      |      (502)942-3232   (703)549-3611
 5 Data tables at A57..G79         |      Ft. Knox, KY    Alexandria, VA
 6 ----------------------------------------------------------------------
 7  Blue Exposure (sec) Until Hit Scored on
 8    Red 1      Red 2      Red 3     Red 4      Red 5      Total    Cor-
 9    MBT of     (MBT      (BMP of   (BMP of     (BMP       Blue    rected
10  (Greatest   appears    Greatest  Secondary  appears     Expo-    Expo-
11    Threat)  @ 10 sec)   Threat)   Threat)   @ 20 sec)   sure     sure
12      4         23         14        35         47         47       47
13
14     **** NOTE: Hit probabilities are notional. ****
15        Probabilities Red Elements Killed
16          0.93      0.46      0.62      0.37      0.34      Final
17                                                          Score
18   /------<----- E(Blue Hits) =      2.707      /---->      71
19  /-------<----- E(Blue Loss) =      0.663      |
20  \------->-----------> Performance Ratio =    4.084
```

Figure 12. Scoring for Performance Example 1.

```
     A      B           C          D          E          F         G      H
 1 TABLE VIII  Extended 1-on-N     'Human Resources Research Organization
 2             Methodology (n = 5, |-------------------------------------
 3 EXAMPLE 2; CRITERION = 1,4,6    |ATTN: Gene Hoffman or Ric Blacksten
 4 Instructions at A100..A141      |      (502)942-3232   (703)549-3611
 5 Data tables at A57..G79         |      Ft. Knox, KY    Alexandria, VA
 6 ----------------------------------------------------------------------
 7 Blue Exposure (sec) Until Hit Scored on
 8   Red 1      Red 2       Red 3       Red 4      Red 5      Total    Cor-
 9   MBT of     (MBT       (BMP of     (BMP of     (BMP       Blue    rected
10 (Greatest   appears     Greatest   Secondary   appears     Expo-    Expo-
11  Threat)   @ 10 sec)    Threat)     Threat)   @ 20 sec)    sure     sure
12    2          22          10          59         999        60       60
13
14     **** NOTE: Hit probabilities are notional. ****
15        Probabilities Red Elements Killed
16          0.98      0.52      0.75      0.33      0.00      Final
17                                                          Score
18   /------<----- E(Blue Hits) =      2.577      /---->      67
19  /-------<----- E(Blue Loss) =      0.667      |
20  \------->-----------> Performance Ratio =    3.865
```

Figure 13. Scoring for Performance Example 2.

```
      A    B         C         D         E         F          G       H
 1 TABLE VIII   Extended 1-on-N         |Human Resources Research Organization
 2              Methodology (n = 5)     |--------------------------------------
 3 EXAMPLE 3; CRITERION = 1,4,6         |ATTN: Gene Hoffman or Ric Blacksten
 4 Instructions at A100..A141           |      (502)942-3232    (703)549-3611
 5 Data tables at A57..G79              |      Ft. Knox, KY     Alexandria, VA
 6 ----------------------------------------------------------------------------
 7 Blue Exposure (sec) Until Hit Scored on
 8   Red 1      Red 2      Red 3      Red 4       Red 5       Total    Cor-
 9   MBT of     (MBT       (BMP of    (BMP of     (BMP        Blue     rected
10 (Greatest   appears    Greatest   Secondary   appears     Expo-    Expo-
11  Threat)   @ 10 sec)   Threat)    Threat)    @ 20 sec)   sure     sure
12    23         35          4          14         47         47       47
13
14     **** NOTE: Hit probabilities are notional. ****
15        Probabilities Red Elements Killed
16          0.40      0.29      0.93      0.58      0.26        Final
17                                                              Score
18   /------<----- E(Blue Hits) =       2.458       /---->        54
19  /-------<----- E(Blue Loss) =       0.740       |
20  \------->----------> Performance Ratio =    3.320
```

Figure 14. Scoring for Performance Example 3.

```
      A    B         C         D         E         F          G       H
 1 TABLE VIII   Extended 1-on-N         |Human Resources Research Organization
 2              Methodology (n = 5)     |--------------------------------------
 3 EXAMPLE 4; CRITERION = 1,4,6         |ATTN: Gene Hoffman or Ric Blacksten
 4 Instructions at A100..A141           |      (502)942-3232    (703)549-3611
 5 Data tables at A57..G79              |      Ft. Knox, KY     Alexandria, VA
 6 ----------------------------------------------------------------------------
 7 Blue Exposure (sec) Until Hit Scored on
 8   Red 1      Red 2      Red 3      Red 4       Red 5       Total    Cor-
 9  (MBT of     (MBT       (BMP of    (BMP of     (BMP        Blue     rected
10  Greatest   appears    Greatest   Secondary   appears     Expo-    Expo-
11  Threat)   @ 10 sec)   Threat)    Threat)    @ 20 sec)   sure     sure
12     4         14         23          35         47         47       47
13
14     **** NOTE: Hit probabilities are notional. ****
15        Probabilities Red Elements Killed
16          0.93      0.61      0.49      0.40      0.37        Final
17                                                              Score
18   /------<----- E(Blue Hits) =       2.800       /---->        76
19  /-------<----- E(Blue Loss) =       0.632       |
20  \------->----------> Performance Ratio =    4.431
```

Figure 15. Scoring for Performance Example 4.

example, Red 3 (the BMP) is hit first, illustrating the decision to complete servicing the BMP beyond the time Red 2 (MBT) appears. That decision results in a Blue exposure of 13 seconds to Red 2. Example 4 illustrates an alternative Blue decision of shifting fire to Red 2 as soon as it appears and then returning to Red 3. As a result, expected Red losses are higher and expected Blue losses lower for Example 4.

The spreadsheet presents two types of graphs that illustrate the calculation of expected hits. The first graph depicts the portion of the scoring algorithm which summarizes Blue probability of survival information. The graph from the second example is presented in Figure 16. In this graph, each numbered line indicates the cumulative probabilities of Blue surviving a particular Red target. These curves begin as simply the reverse of the cumulative hit probabilities (Figure 11). Thus, the chances of surviving any particular vehicle decrease with elapsed time. However, when a target is hit, the curves flatten indicating there is no additional threat from the hit target. The lower line (labeled "Survive all Red") indicates the Blue probability of surviving all Red vehicles. At any point in the engagement, the probability of surviving all Red targets is the product of multiplying the probabilities of surviving each threat target. Thus, points along the cumulative survival probability line are constructed from the time splice products of points from all of the other lines.

Figure 17 presents the second type of graph on the spreadsheet program and illustrates the logic of calculating Blue hits on Red. In Figure 17 which is based on Example 2 above, the curve "Survive all Red" is carried over from Figure 16. The probability of any Red being hit is the probability that Blue survives to the time that Red was hit. Thus, Red 3 was hit at 10 seconds, so a horizontal line of 3s is drawn that intersects the Blue "Survive all Red" line at 10 seconds. The line of 3s that intersects the Y-axis (vertical axis) at the point (.75) that gives Blue probability of surviving all targets to 10 seconds and therefore the probability of Red 3 being hit had all the targets been shooting. Notice that Red 5 was not hit in Example 2. Thus, Figure 17 shows a line of 5s along the bottom of the graph indicating that Red 5 had a 0% chance of being hit.

These examples illustrate the capability of the spreadsheet for "what if" gaming. Once cumulative hit probabilities are entered for threat targets, questions concerning target hit times and target orders can be explored as well as questions concerning cutoff criterion. The spreadsheet is set to convert performance ratios (i.e., hit expectation ratios) to points with user input of the three hit expectation ratio break points automatically being converted to 0, 70, and 100 points.

Aggregating engagement performance ratios. These calculations provide hit expectation ratios for any single tank engagement. On the other hand, a test of crew gunnery proficiency will consist of a sample of engagements, each of which will be scored according to the hit expectation algorithm. The next problem is the aggregation of these engagement ratios to yield a summary metric of performance.

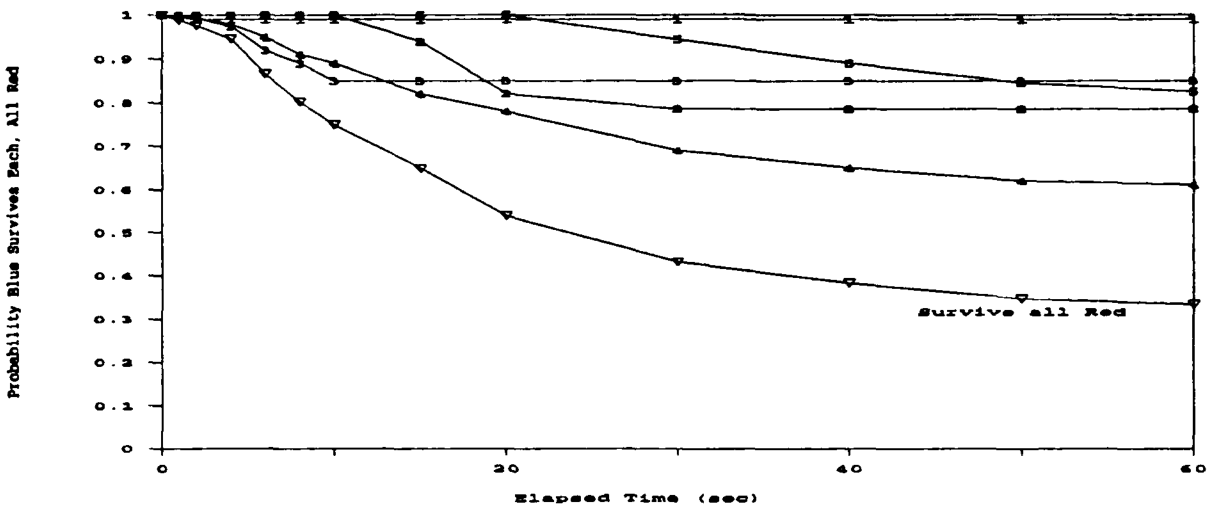

Figure 16. Survival for Performance Example 2.

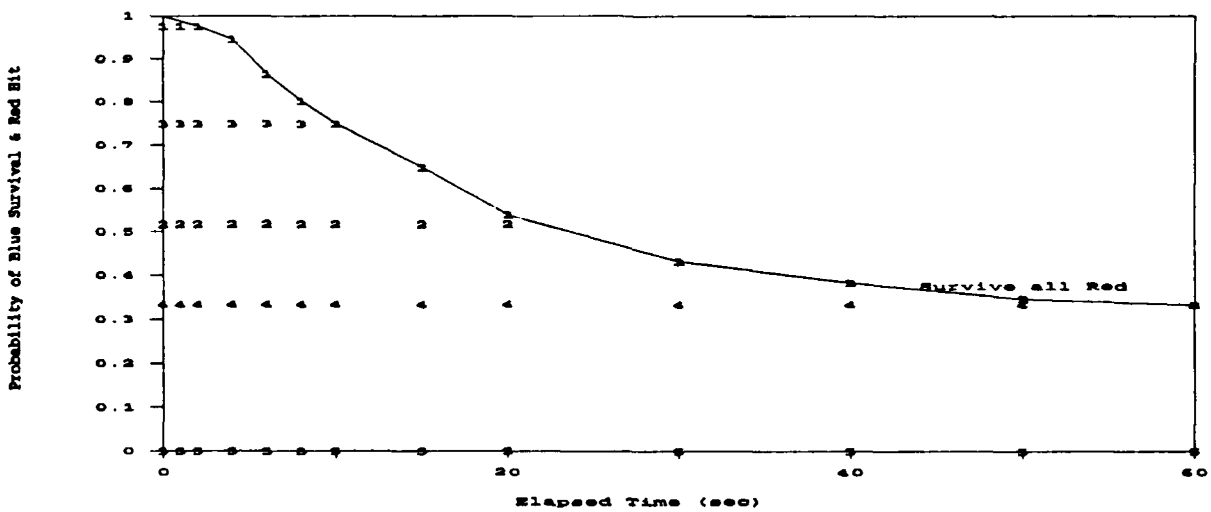

Figure 17. Probabilities for Blue hitting each Red based on probability of Blue survival.

As described above, hit expectation ratios will vary as a function of a number of engagement conditions, most notably the number of threat targets. For a sample of engagements, we may expect wide variations in means and standard deviations of hit expectation ratios. As pointed out earlier, across different types of engagements there is not a one-to-one correspondence between hit expectation ratio and proficiency. Consequently, attempts to generalize and interpret engagement level hit expectation scores beyond anything but very similar engagements is, at best, ambiguous and may be misleading. The hit expectation ratio scale *as a measure of proficiency* is not absolute. On the other hand, it is an acceptable *relative* index of proficiency. For a given engagement, higher hit expectation ratio scores indicate higher proficiency, and for a given set of engagements, higher average hit expectation ratio scores indicate higher proficiency. Thus, averaging hit expectation ratios is an acceptable strategy for assessing differences in gunnery proficiency among tank crews.

Actually, it is our contention that hit expectation ratios should be treated as only a relative index of proficiency even at the engagement level. There are numerous assumptions and decisions in the computation of the cumulative hit probability curves on which hit expectation ratios are based, and there are numerous intangibles related to psychological reactions under fire (on either side). Both of these factors make the cumulative hit curves arguable in any absolute sense. However, a hit expectation ratio can serve as a useful relative index of proficiency. Crews with higher hit expectation ratio scores have higher proficiency as defined by speed, accuracy, and survival. Likewise, in an actual battle, we may expect that, in general, crews with higher hit expectation ratio scores will fare better. On the other hand, the hit expectation ratio scores should not be interpreted as an absolute or direct index of whether or not crews will defeat the threat. There are just too many variables. This does not diminish the significance of hit expectation as a useful, but relative, index of gunnery proficiency.

There is one modification to averaging hit expectation ratio scores. To the extent that hit expectation ratio scores have different variances across different engagements, the contribution or influence of the different engagement scores to the average score will vary. Therefore, assuming that the intention is that the engagements in the test are equally important and should contribute equally to the average score, the engagement hit expectation ratio scores should be adjusted to equate their variances (i.e., standardize) prior to calculating test average hit expectation ratio.

Platoon Gunnery Scoring

The next level of complexity is the consideration of platoon level scoring. This implies extension of the hit expectation ratio calculations from one-on-n to four-on-m. The concept still relies on the calculation of expected Blue hits and expected Red hits in a manner analogous to the 1-on-n case. The central task is to determine the probability of survival of each Red and Blue element in an actual engagement comparable (as nearly as can be defined) to the test engagement.

Let $P(S_{BiTi})$ be the probability that Blue element i would still be alive (i.e., not hit) at time t_i, and let $P(S_{RjTi})$ be the comparable probability of survival for Red element j. Let t_{end} be the length of the engagement. Let

$P(H_{Bi}) = 1 - P(S_{BiTe})$ be the probability that Blue i is killed (hit) by the end of the engagement. Similarly, let $P(H_{Rj}) = 1 - (P(S_{RjTe}))$ be the probability that Red j is killed in the engagement. Once these are found, the expected Blue and Red losses may be computed as

$$E\text{ (Blue Loss)} = P(H_{B1}) + P(H_{B2}) + \ldots + P(H_{Bm}) \tag{11}$$

and

$$E\text{ (Red Loss)} = P(H_{R1}) + P(H_{R2}) + \ldots + P(H_{Rn}) , \tag{12}$$

and the hit expectation ratio is computed from

$$\text{Hit Expectation Ratio} = \frac{E\text{ (Blue Hits)}}{E\text{ (Red Hits)}} = \frac{E\text{ (Red Loss)}}{E\text{ (Blue Loss)}}. \tag{13}$$

The above computations are a straightforward extension of the 1-on-n probability manipulations. However, calculation of the probability of survival values takes on a considerably different light. For the 4-on-m case, survival estimate requires consideration of targeting decisions and the modeling of Red fire distribution.

Trying to determine what would have been the outcome of an engagement if both sides were firing--based on results when only one side is firing--is complex. Beyond the one-on-n situation, it is conceivable that there exists no provably valid analytic solution. In any case we, as others, have found none. It is too much like trying to "go back to the future," in that had Red and Blue actually been firing on each other and inflicting kills, the Blue platoon could have had very different target selection histories. For example, suppose Blue 2 switches fire from Red 3 to Red 1 during the engagement because Red 3 is hit by Blue 4. In an actual battle, Blue 4 might be knocked out before hitting Red 3, in which case Blue 2 would continue to fire at Red 3. Of course, the firing distribution of Red is speculative in any case. Perhaps it is possible to score platoons using a Monte Carlo simulation, where hit times on Red targets are constrained to Blue observed hit times. However, this approach would require a large amount of computer time per platoon in order to reduce stochastic uncertainty. It is doubtful that such a Monte Carlo approach would be acceptable as a scoring algorithm because (a) it would be long running and (b) crews would probably object to being scored by a <u>random</u> simulation. A better solution would be an algorithm that approximates the process and gets its answer in one pass. Such a solution can be achieved through an incremental series of loops over time from time zero to termination of the engagement. Because such an analytic algorithm calls for no random numbers, repeating the algorithm with the same Blue hit times would produce the same result each time.

A targeting algorithm has been developed in which Red fire distribution is probabilistically apportioned to the Blue targets. The core of the algorithm is sketched in Figure 18. The thrust of the algorithm is that at each instant of time every Red element will be targeting one of the Blue elements providing there is line of sight. The target selection should reflect both the ability of the firer to inflict damage on the enemy element and the ability of the enemy element to inflict damage on the firer. The

$t = 0$

<u>Determine Red targeting on Blue</u>.
Set the probability that Red j targets Blue i equal to the "probable mutual threat", adjusted by the probability that Blue is still alive and by the probability of line of sight, normalized over all Blue targets:

$$P(T_{RjBiTk}) = \frac{H_{BiRjTk} * H_{RjBiTk} * P(S_{BiTk}) * L_{BiRjTk}}{\underset{j}{\mathrm{SUM}} \; H_{BiRjTk} * H_{RjBiTk} * P(S_{BiTk}) * L_{BiRjTk}}$$

<u>Update Blue survival probability</u>.
The probability that Blue i will survive to time t + dt decreases according to

$$P(S_{BiTk+dt}) = P(S_{BiTk}) \prod_{j} (1 - P(S_{RjTk}) * P(T_{RjBi}) * H_{RjBiTk}$$

<u>Update Red survival probability.</u>
If $t < t_{ij} <= t+dt$, then assess the Blue i hit on j, but account for the probability that Blue is alive to fire the shot:

$$P(S_{BiTk+dt}) = P(S_{RjTk}) * P(S_{BiTk})$$

$t = t + dt$

Figure 18. Probabilistic targeting algorithm for M-on-N probability of survival calculation.

danger posed by an enemy element is zero if that element is dead; however, the present algorithm does not assess hits dichotomously so the *viability of a threat element is handled probabilistically.* This is the key to this algorithm. Thus, the probable mutual threat between Blue i and Red j is

$$H_{BiRjTk} \;*\; H_{RjBiTk} \;*\; P(S_{BiTk}) \;*\; L_{BiRjTk}$$

where:

HBmRjTk = instantaneous hit rate of Blue i against Red j should Blue i choose to fire on Red j,

H_{RjBiTk} = instantaneous hit rate of Red j against Blue i should Red j choose to fire on Blue i,

$P(S_{BiTk})$ = probability that Blue i is alive (unhit) at time k, and

L_{BiRjTk} = line of sight probability indicator.

Figure 18 indicates that to score a platoon's performance, the algorithm would cycle over time increments (e.g., iterating every two seconds). For each time increment, Figure 18 indicates three calculations, each enclosed in a box. In the top box, targeting decisions are modeled for each Red target and each Blue vehicle resulting in an estimate of Red_i targeting $Blue_j$ for each ij combination. Again, these estimates are based on a "mutual threat" rule in which Red's likelihood of targeting a particular Blue varies as a function of four factors. From right to left in the numerator of the formula, Red is more likely to target Blue vehicles that (a) are more likely to be visible, (b) are more likely to be alive, (c) that Red has a greater chance of hitting, and (d) that are more threatening to Red. The formula does not provide a discrete indication of which Blue is targeted by a Red, but rather it provides the *probability* that a Blue i is targeted by a Red j at time k.

The concept "instantaneous" simply means that hit rates are not constant but vary as a function of elapsed time. Instantaneous hit rate underlies the cumulative hit probability curves now employed in Table VIII and can be recovered from these curves using the calculus of probability. If $P(H_{BiRjTk})$ is the Table VIII probability that Red j has achieved a first hit on Blue i by time t_k, then the instantaneous probability density function for first hit, H_{RjBiTk}, is apparently $p(H_{BiRjTk})/[1-P(H_{BiRjTk})]$ where $p(H_{BiRjTk})$ is the derivative of $P(H_{BiRjTk})$. Alternatively, the hit rate can be estimated from first principles (i.e., rate of fire times conditional probability of hit given miss).

In the middle box in Figure 18, survival probability for each Blue vehicle is adjusted for the increase in elapsed time. Blue's survival at the end of the time interval is the product of its survival at the end of the previous time interval multiplied by its expected survival, during the

current time interval, from the threat of each of the Red.[6] Blue survival for any given Red (e.g., Red_j) is based on the probability that during that particular time interval Red_j is targeting the Blue ($P(T_{RjBi})$), the hit rate capability of the Red on the Blue during that time interval H_{RjBiTk} and the probability that Red has survived to the beginning of the time interval in order to do the shooting $P(S_{RjTk})$. In the first iteration through this step, Blue's prior probability of survival $P(S_{BiT0})$ and Red's probability of survival $P(S_{RjT0})$ are both set to 1.0.

In the bottom box in Figure 18, each Red's survival probability (to be used in the next iteration of the algorithm) is corrected for the events that occur in the current time interval. If a Red target is hit by a Blue vehicle in the given time interval, then Red's survival at the beginning of the interval $P(S_{RjTk})$ is multiplied by the probability that the Blue that hit the Red would have survived to that point $P(S_{BiTk})$. This is the same logic used in the 1-on-n version to estimate expected Blue hits on Red.

At the end of the last iteration of the algorithm (corresponding to the length of the engagement), survival probability estimates will be available for each Blue and for each Red. As indicated above, these are converted to probabilities of being hit and subsequently into a hit expectation ratio. Note that the scoring algorithm requires Blue cumulative hit probability curves as well as Red cumulative hit probability curves. Thus, in a sense Blue platoons are scored against some normative statement of Blue capabilities. Thus, higher hit expectation ratios will be achieved to the extent that the Red vehicles that are most threatened by the Blue are hit first, other things being equal. Using this algorithm, a mix of Blue vehicles (e.g., M1's and M2's) could be scored with appropriately different results for similar performance.

This scoring algorithm represents one of any number of ways in which Red fire distribution on Blue could be modeled. A simple change could be to explicitly assign a particular Blue target to each Red according to which Blue represented the maximum mutual threat. Other changes could be made in computation of the mutual threat. For example, the Blue vehicles that Red could target could be constrained by some delineation of Red's sector of fire. Thus, any given Red could only target those Blue's that are in its sector. Or, instead of a mutual threat rule, Red targeting might be calculated based on only Blue threat to Red or only on Red capability of hitting Blue. Furthermore, lengthy debates could occur over which of these, if any, gives the most realistic results.

For proficiency testing, the absolute realism of the results is not as important as how well the algorithm orders platoons on proficiency criteria of speed, accuracy, and survivability. Thus, an algorithm may yield a hit expectation ratio of 4.0 for some particular pattern of platoon performance for some engagement where with more sophisticated modeling or repeated

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[6]The symbol π in Figure 18 is interpreted as follows:

$$\prod_j A_j = A_1 * A_2 * A_3 * \ldots * A_j.$$

performance on an actual battlefield the hit ratio is 5.0. On an absolute scale, the algorithm is likely to be in error in that it is not strictly indicative of battlefield hits and survival. However, if that error is relatively constant across a variety of engagements and performance patterns (i.e., hit expectation ratio is constantly too high or too low) then the resulting scores are valid representations of relative differences in performance among platoon. Such results are perfectly acceptable for conducting comparisons of different training packages. The important question regarding different methods of modeling fire distribution concerns the correlation among scores resulting from the different methods. Mean differences in scores produced by different algorithms are much less important.

Implementation. The M-on-N algorithm, as proposed or with any of the suggested modifications, is computationally more complex than the 1-on-n algorithm. It would need to be programmed in a language such as FORTRAN or C but could easily run on a desktop computer. At this time, there is not sufficient justification for producing such a program.

Should justification arise for producing such a program, steps should also be taken to in some way valididate the results. There are several options. At a minimum, two or three versions of the targeting routine (e.g., mutual threat, one-sided threat, threat within sector) should be produced, applied to a hypothetical data set, and the results compared. This would indicate the extent to which targeting rules produce scores that order different patterns of performance the same way. A second option is to validate algorithm scores against force-on-force performance although obtaining data would be difficult. Finally, one could also conduct research comparing the algorithm to stochastic (Monte Carlo) simulation. AMSWAG or CARMONETTE might be employed if the administrative arrangements can be worked out. Alternatively, one might use one of the newer discrete event simulation languages (e.g., MicroSaint) to develop a new, *ad hoc* simulation. Or one may exhume some suitable older simulation (e.g., Small Unit Generalized Attrition Routine [SUGAR]).

Summary

In this section, hit speed and accuracy scoring for crew and platoon gunnery have been discussed. In either case, the logic, which is based on current Table VIII scoring, is to estimate expected Blue hits on Red and expected Red hits on Blue given that only Blue is firing. This requires estimation of Red capabilities and manipulation of probability distributions to trade-off observations of Blue performance against expected Red performance. The ratio of expected Blue hits on Red to expected Red hits on Blue, called hit expectation ratio, is the resulting metric for assessing gunnery speed and accuracy. Because Red capabilities are used in the calculation, the metric also incorporates an evaluation of Blue's targeting of Red in order of threat magnitude. Scoring for crew gunnery is fully developed with a spreadsheet algorithm for up to five Red targets. Instructions for that spreadsheet are presented in Appendix A. Scoring for platoon gunnery is complicated by the need to determine Red's distribution of fire. The mathematics of a suggested solution is presented, but a spreadsheet implementation was not developed.

Setting Performance Standards for Gunnery Outcomes

Having described the intricacies of the hit expectation ratio metric of gunnery performance, it should be clear that setting performance standards is not as straightforward as it has been presented by the Armor community's development of the current Table VIII, the recommendations for the proposed Table XII, or by TRAC-WSMR. However, it is also clear that attempts to base hit expectation ratio standards on estimates of force ratio doctrine between Blue and Red will only blur the distinction among three different concepts: the standard, the size of engagements, and overall force ratios. As has been repeatedly stated, hit expectation ratio is situation specific: Values from any one engagement do not generalize beyond conditions very similar to that engagement. As stated earlier, that a Blue crew (or platoon) can achieve a five-to-one hit expectation ratio against a force ratio of one-to-one or two-to-one tells little, if anything, about its potential hit expectation ratio against a force ratio of five-to-one. Thus, hit expectation ratio, as the best of the alterative gunnery metrics, does not provide a benchmark for determining whether or not tank gunnery proficiency is sufficient to defeat the threat.

At this point, we need to review some other reasons for setting standards. Three reasons for setting standards are commonly cited by Army trainers.

1. To provide an administrative index for judging the quality of unit training (DA Pam 350-38, Department of Army, 1988a).

2. To provide an administrative index for training decisions for crews and platoons concerning the need for remedial training (FM 17-12-1, Department of Army, 1986).

3. To provide a training goal to motivation achievement.

The first and second reasons can just as easily be supported by direct comparison of scores. That is, unit commanders could be compared to each other on the mean scores of their crews and platoons as easily as on the percent of their crews and platoons that qualify with passing scores. The same holds for reason number three. Certainly crews that fail to qualify get more training attention that crews that don't; however, unit training does not stop for crews and platoons that do qualify. Training continues as a cyclical series of events. Regardless of the standard, low scoring crews and platoons should receive more attention, and all crews and platoons should continue trying to improve. The third reason changes the meaning of the standard from one of minimum acceptability to a definition of desirable aspiration.

Note that none of these reasons is directly related to evaluative research designs that compare alternative methods or amounts of instruction. It is tempting to declare that standards are not needed fc, such comparative research. For simple research designs in which a particular amount of one method is pitted against a particular amount of another method, standards are not necessary. However, for more sophisticated research designed to compare trade-off functions along the continuum of skill acquisition, standards can cue decision-makers where to focus their attention along the acquisition curve. The following example illustrates this point.

In order to answer trade-off questions, we first need to think in terms of the amount of proficiency gained by experience. In general, proficiency increases by a relatively lawful process that may be depicted by learning curves. Figure 19 shows learning curves like those used by Campbell and Hoffman (1990) in an earlier report in this series.[7] A similarly shaped function was also found to represent the cross-sectional relationship between amount of crew experience and Table VIII performance (Hoffman, 1989). In Figure 19, proficiency increases with experience for both Method X and Method Y, but the amount of increase differs for X and Y. In addition, the amount of increase in proficiency depends on where on the learning curve we're looking. Interesting questions arise when cost considerations are included. For example, assume that Method X represents live fire and Method Y represents a simulator, and further assume that Method X is two and a half times as costly as Method Y. Figure 19 may be replotted as a function of cost as presented in Figure 20. Now the significance of making decisions in relation to standards becomes apparent.

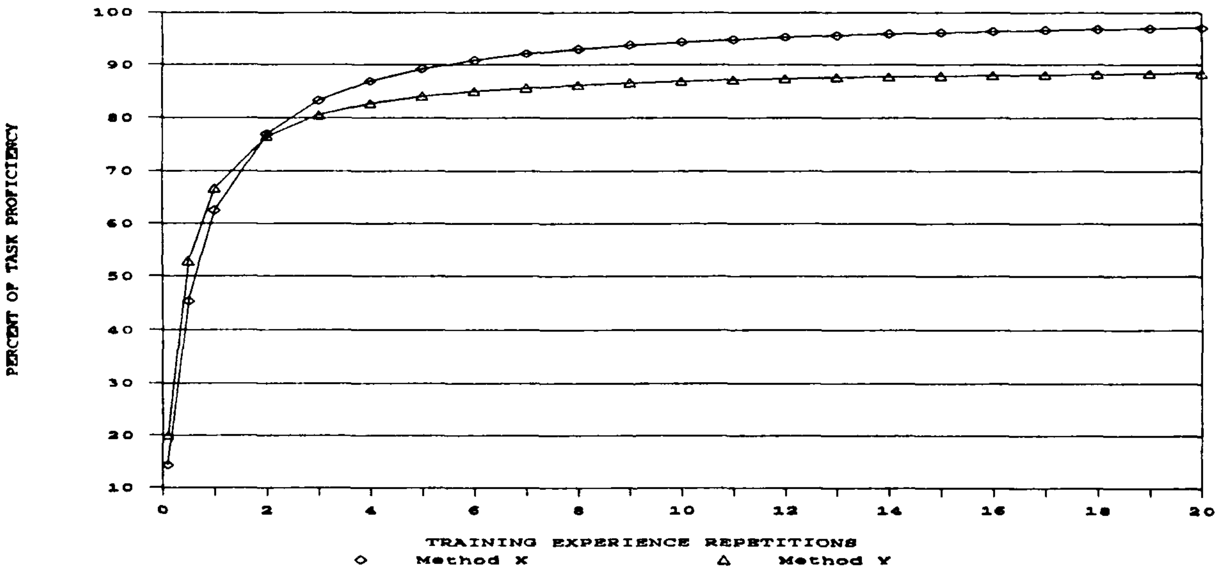

Figure 19. Task proficiency as a function of different kinds of practice.

[7]The equations are hyperbolic function. For Method X, it is:

$$\text{Proficiency} = \frac{\text{Repetitions}}{\text{Repetitions} + .6} * 100;$$

and for Method Y:

$$\text{Proficiency} = \frac{\text{Repetitions}}{\text{Repetitions} + .5} * 90.$$

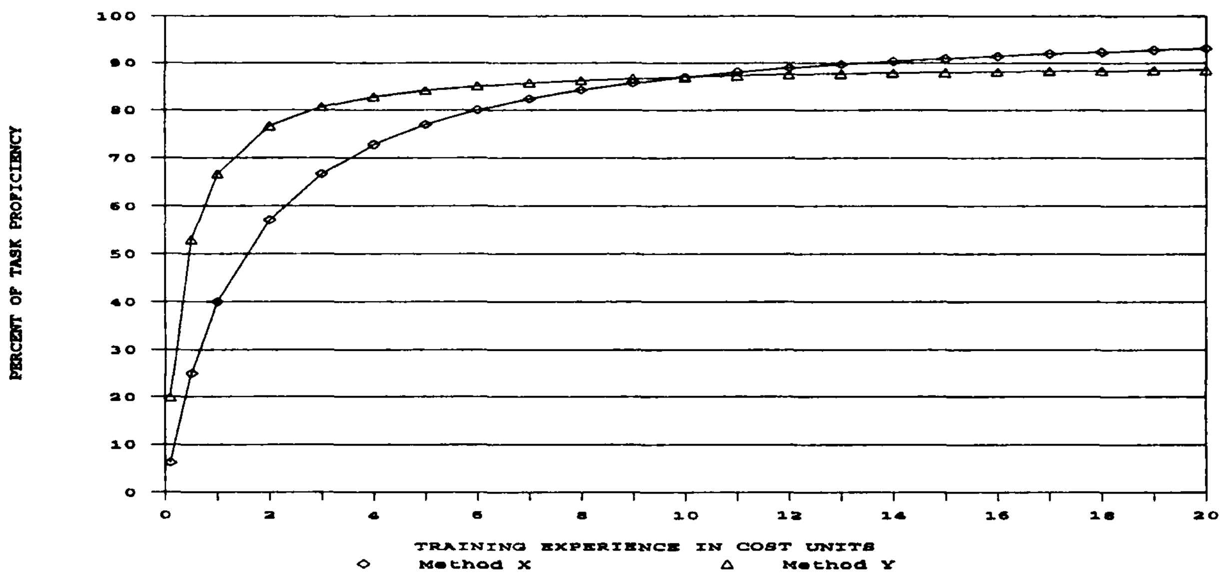

Figure 20. Task proficiency as a function of training costs.

This example has been constructed such that early in training the Method Y simulator evokes faster learning per dollar spent, but by itself it is incomplete with performance asymptoting at 90% proficiency. Note the difference in training decisions that might be made if 80% proficiency is the standard versus 90% proficiency. The Method Y simulator trains the task to 80% proficiency cheaper than the Method X real equipment. If 80% were the performance standard, one might decide to conduct all training on the simulator. On the other hand, if the performance standard were 90% a combination of simulator and real equipment might be recommended.

Note two important and rather sticky assumptions are implicit in the above argument. First, we once again need to repeat that we do not have a very good handle on the relationship between measures of gunnery performance and crews' underlying proficiency. Even for a given engagement in which conditions are constant, we cannot convert hit expectation ratio into a "percent of task proficiency" index. Extensive empirical data collection would be needed to construct skill acquisition curves to find out how fast and accurately crews can be against engagements with three or more targets. In the absence of such normative data, standards set in terms of hit expectation ratio do not provide much guidance for interpreting relative utilities of training methods.

The second assumption in the above analysis is that differences in proficiency above the standard are relatively unimportant. That is, in the above example, a decision based on training only up to the 80% level would not use actual equipment, but it is at that point that training on the real equipment begins to have its payoff. Only if one were to consider the full range of potential performance regardless of the standard is the use of the

actual equipment economically justified. In this hypothetical example, the deciding factor is whether or not to train for proficiency beyond the set standard. The assertion that proficiency greater than the standard is unimportant is not credible. A standard is set as the minimum acceptable level, not the maximum, or even the most desirable level. Certainly, there are time and resource limits on the amount of training, but training research should focus on stretching those time and resources limits as far as possible in terms of maximum proficiency.

At the beginning of this argument, we carefully used the phrase "decision-maker" rather than researcher. It is our contention that research should be conducted to track performance gains well beyond any set standard. Results from that research can then be used by decision-makers to determine how much of the limited training resources to invest in practicing gunnery. As the example illustrates, setting standards prior to tracking performance may be ill-advised, particularly for those who advocate live-fire training.

A final comment before drawing a conclusion. Gunnery standards are a highly visible and volatile issue. Because unit gunnery performance is based on the percent of crews and platoons that qualify, difficult standards are perceived by unit commanders as a threat to their Officer Efficiency Ratings (OERs). The payoff for explicitly setting standards for research is minimal. On the other hand, the political risks are tremendous. At the present time, an effort to update Table VIII hit expectation ratio calculations for increased threat capabilities is stalled. The Armor community appears reluctant to change a system that is only marginally understood to begin with.

Summary and Conclusion Regarding Gunnery Standards for Training Research

Four arguments have been proposed concerning standards for gunnery speed and accuracy. They are:

1. Hit expectation ratio standards cannot address questions about defeating the threat.

2. Hit expectation ratio standards are not required for training research, and they may lead to inappropriate conclusions.

3. Hit expectation ratio standards cannot be set in the absence of performance data.

4. The standard setting issue for gunnery is politically very volatile.

These arguments point to one conclusion. Training research may progress further and with less resistance without gunnery outcome standards than with them. Our conclusion, then, is that now is not the time for researchers to become involved in setting standards for speed and accuracy of tank gunnery.

Chapter 4. Measurement of Tank Gunnery Process

The discussion of the previous chapter centered on the outcome assessment of the speed and accuracy of target hits. In addition, there are procedural aspects of performance that are crucial to crew and platoon gunnery. This chapter examines process measures that focus on these procedures. It begins with a review of the process scoring aspects of Tables VIII and XII and continues with the introduction of crew, platoon leader, and platoon measurement instruments for assessing the gunnery processes requiring evaluation according to our measurement specifications in Chapter 2.

Scoring Gunnery Procedures

In their current versions (FM 17-12-1, Department of Army, 1986), Table VIII and Table XII assess gunnery procedures with different scoring methods. Whereas the scoring on Table VIII calls for deducting points for procedural errors, Table XII scoring prescribes that points be added for correct responses. The scoring procedures are described in more detail in the following two sections.

Table VIII

In Table VIII scoring, procedural errors are referred to as "crew duties penalty points." The three categories of crew duties, their point values, and sample items are listed Table 10. Crew duties penalty points are accrued separately for each engagement and are subtracted from the speed and accuracy points for that engagement. Therefore, the final score for each engagement reflects a combination of two evaluations: (a) speed and accuracy and (b) procedural errors.

A crew can accumulate a maximum of 30 crew duties penalty points for any given engagement. For example, a crew that did not search for targets between engagements (5 points) and left the ammunition compartment door open during an engagement (10 points) is deducted 15 crew duties penalty points. However, a crew that fired at a friendly target (30 points) and did not search for targets between engagements (5 points) is penalized only 30 crew duties points. Furthermore, penalty points for crew duties are accumulated by categories, not separately for each error. Consider a crew using an incorrect fire command (5 points) and firing at the least dangerous target first (5 points) during an engagement. Five crew duties penalty points are deducted for failure to use the correct engagement technique, not five points for each error. In addition, crew duties penalty points can be adjusted during the After Action Review (AAR). If a crew can demonstrate that an error was made in scoring crew duties, the evaluator may readjust the score.

A crew could conceivably make so many errors as to call into question their knowledge or skill in the use of proper procedures. However, because (a) crew duties penalty points can sum to a maximum of only 30 points per engagement and (b) penalty points are accumulated by category, a crew can still earn a passing score on Table VIII by fast, accurate firing. For example, a crew could earn 100 points for hitting targets quickly and be deducted the maximum 30 points for crew duties penalty points. That crew would be awarded 70 points on the engagement, which is considered a passing score. The implication is that, if a crew can hit targets quickly enough, procedural errors are relatively unimportant.

Table 10

Tank Table VIII Penalty Categories and Sample Procedural Errors

I. Failure to adhere to required conditions of the task. **30 Points.**

A. Not masked or buttoned up during NBC engagement.
B. Using thermal imaging system (TIS) during illumination engagement, or any sight other than the one specified for an engagement.
C. Using components of the fire control system that are degraded in the engagement conditions.
D. TC not firing his main gun engagement.
E. Using ammunition incapable of killing the target.
F. Using the wrong weapon for target effect. If a weapon or portion of the fire control system malfunctions, no penalty will be taken for engaging the target with an alternate weapon if it is capable of killing the target.
G. Firing at a friendly target array, if used, regardless of whether or not targets were hit.

II. Failure to adhere to basic safety precepts. **10 Points.**

A. Failure to follow the instructions of the Tank Crew Examiner, control or safety officer, or unit commander while on the course.
B. Loader's shoulder guard and knee guard not in proper position.
C. Laser-protective filters are not mounted (does not include eye-safe system for laser range finder [ESSLR]).
D. Leaving spent case ejection guard in ARMED position or GUN SELECT switch to MAIN or COAX when loading.
E. Loader having round in hands between engagements unless the TC has announced a change in fire control posture or battle carry, loader is loading the main gun, or loader is repositioning ammunition.
F. Failure to close ammunition compartment door during an engagement.
G. Firing before receiving "FIRE" or announcing "ON THE WAY."

III. Failure to use correct engagement technique or method. **5 Points.**

A. Incorrect initial or subsequent fire command. Any word or phrase the TC may use that accurately describes the location or action of the target at which he desires to fire (near, close, moving, stationary, distant, left, right, far) is adequate.
B. Gunner not searching for target between engagements.
C. Incorrect response to a fire command or subsequent fire command. If the gunner acquires all of the targets in an engagement before the TC, the gunner does not need to announce "IDENTIFIED."
D. Loader not searching for targets between engagements or not observing during TC caliber .50 engagement (unless loading the main gun).
E. Gunner fails to hit in the target area with the initial (killing) burst on an area troop engagement.
F. Incorrect engagement sequence (firing at the *least dangerous* target first) during a multiple target engagement.

Note. Taken from FM 17-12-1.

Table XII

Adherence to procedures on the standard Table XII in FM 17-12-1 (Department of Army, 1986) is expressed in a tactical proficiency score. A tactical proficiency checklist consisting of a series of YES/NO items is provided for each engagement. Although some items require more than one response, each depicts a potential error. Items are worded such that a "no" response indicates that an error was made. Although the checklist varies for each engagement, the items address (a) platoon leader performance, (b) platoon performance, (c) the interaction among tanks in the platoon, and (d) the interaction between the platoon leader and the platoon.

Because some errors have more serious consequences than others, items (i.e., errors) are weighted according to the following criteria:

1. Errors that increase the risk to one or more tanks in the platoon or place the entire mission in jeopardy - **3 points**

2. Errors that have no immediate effect on the platoon's mission but may impact on higher echelons or adjacent units' missions - **2 points**

3. Procedural and doctrinal errors that are not conducive to efficient interaction between tanks or platoons - **1 point**

Unlike Table VIII procedural scoring in which points are deducted for errors, Table XII scoring awards points for the correct performance of tactics and procedures. Because a "Yes" response indicates correct performance, the points assigned to checklist items with "Yes" responses are summed. Points are neither summed or deducted for items with "No" responses. The tactical proficiency score, which is calculated for each engagement, is the proportion of the total points associated with "yes" responses to total possible points multiplied by 400 to make a perfect score equal to 400. Total possible points are a function of differences in training areas. For example, some training areas impose safety restrictions during live firing which in turn make certain checklist items not applicable. Irrelevant items are dropped from scoring so as not to penalize platoons.

Two scores are determined for each engagement: (a) speed and accuracy and (b) tactical proficiency. The two scores are summed across engagements with speed and accuracy comprising 60% and tactical proficiency comprising 40% of the overall score. Like Table VIII, speed and accuracy on Table XII is given greater weight in determining total score. However, unlike Table VIII, procedural errors on Table XII could cause a platoon to be rated unqualified. Platoons must earn 70% of the possible score (i.e., 700 out of 1000) in the combination of gunnery and tactical proficiency to qualify on Table XII. On the other hand, a platoon would have to miss 75% of the tactical points in order to fail on procedural errors alone.

A standard checklist is not used for all 10 Table XII engagements; although some items appear on more than one checklist, and three appear on every checklist. A content analysis of the 10 checklists revealed 57 unique items. Given that the evaluator must observe a platoon (i.e., four tanks) engage multiple targets and that he must record the number and speed of target hits, it is unrealistic to expect him to complete a 57 item checklist for each engagement. While it seems logical to limit the number of checklist items per engagement, the Table XII checklists do so in an unsystematic manner.

The total number of items on any given checklist ranges from 18 to 24 with total possible points ranging from 35 to 64. Table 11 presents the number of one-point, two-point, and three-point items for each engagement checklist. The discrepancy in item content, number of items per checklist, and total possible points per checklist does not appear to be attributable to differences in engagement conditions. In other words, the number and type of threat vehicles, the range and posture (i.e., moving or stationary) of those

Table 11

Table XII Checklist Breakdown

Mission Engagement	1-Point Items	2-Point Items	3-Point Items	Total Items	Total Points
Defense					
1	10	3	9	22	43
2	8	3	7	18	35
3	9	3	11	23	48
4	9	3	11	23	48
5	10	3	9	22	43
Offense					
1	10	2	12	24	50
2	10	2	12	24	50
3	9	3	7	19	64
4	7	3	9	19	40
5	8	3	9	20	41

vehicles, offense versus defense, the presence or absence of an overwatch element, or time of day (i.e., day versus night) does not seem to explain checklist heterogeneity.

Summary

For tank gunnery training research purposes, the procedural scoring systems for Tables VIII and XII are limited in their abilities to discriminate among the training options being compared. Table VIII's assessment of errors, safety, and test administration issues are obscured by the scoring system. Penalty points are aggregated within category with a ceiling that masks the particular errors and the extent of those errors. Table XII tactical proficiency items are not organized by any kind of skill or task hierarchy. Thus, there are two options for using such data in training research: (a) analyze total procedural/tactical scores and (b) analyze individual items. Neither option is attractive. The first option would provide no detail concerning any differences in training options. The second option of statistically exploring individual items would require large data samples to avoid Type II statistical errors. Therefore, we have opted to develop an auxiliary set of measurement instruments that can relatively simply capture the subtasks identified in Chapter 1.

Development of Performance Metrics

The platoon, platoon leader, and crew performance metrics were developed from the Morrison et al. (1990) analysis of platoon level activities which was presented in Chapter 1. During that analysis, types of performance measures were nominated, but because the purpose of that analysis was not to specify

ways of measuring performance, the measures were tabled for future reference. The current analysis began with the measures previously nominated. Initially, each subtask was to be analyzed individually, and a set of measures was to be established for each task.

Several problems in performance evaluation had to be resolved in order to establish the criteria for a threat-based test. According to Teichner and Whitehead (as cited in Fleishman & Quaintance, 1984), a fairly simplistic set of criterion measures exists which is applicable to the categories of tasks prevalent in gunnery. Probability of acquisition is the criterion measure related to searching task category, which, in turn, relates to the cluster of subtasks associated with target acquisition. Similarly, elapsed time is appropriate for switching tasks (e.g., setting fire control switches); time on target is the metric suggested for tracking (e.g., gun tube orientation, tracking moving targets, maintaining sight picture on stationary targets); and the percent of correct responses is the criterion measure appropriate for processing tasks (e.g., giving fire commands, calling for indirect fire).

The difficulty in applying Teichner and Whitehead's criterion measures in the current situation is the metric applied to processing. A common, familiar method of assessing processes is to determine the percent of steps performed correctly. The reality of combat is that for any given tactical situation, a variety of things might be done. Tactics is such a complex subject that it cannot be reduced to an algorithm of if-then responses. Instead, an heuristic problem solving approach is appropriate. In tactics, there are boundaries, or imperatives, that must be adhered to and a wide range of paths within those boundaries. Defining a single correct response is not always possible.

Because of the imprecise nature of tactics and the multitude of potential responses that need to be scored, a binary checklist was deemed inappropriate. A checklist is convenient in that an evaluator can observe an exercise and merely check whether or not the crew, platoon, or platoon leader performed a specified behavior. Checklist items that are not applicable can be dropped from scoring so as not to penalize the crew, platoon, or platoon leader. However, the very aspect that makes a checklist so desirable (i.e., its simplicity) is disadvantageous from a testing perspective.

Our goal of proficiency testing to support training research is to provide information at a level of detail described by the subtasks represented in Chapter 1. Such test scores must reflect performance on distinct segments of training. If a composite score is used to summarize performance across several training segments, it should be easy to separate by training segment. Table VIII penalty categories and Table XII checklist items are not organized by procedural dimensions (e.g., movement, communication, etc.); therefore, one cannot identify a unit's strengths and weaknesses by dimension. A rating scale *for each dimension* of tactical and procedural performance would show a unit's strong points and deficiencies.

A rating scale also provides a statistical advantage over a binary checklist. Sample size, statistical power, and the number of variables to be measured are interrelated. Statistical power increases with sample size. As the number of variables to be measured increases, sample size must increase proportionally to provide enough statistical power for meaningful analyses.

In assessing platoon and platoon leader performance, the sample sizes typically available are quite small. There are four tanks in a platoon and roughly 12 platoons in a battalion. Even if *complete* data could be collected on an entire 12 platoon battalion, a sample size of 12 does not yield very much statistical power. In other words, a sample size of 12 does not provide enough statistical power to analyze differences on the 57 unique Table XII items, many of which are repeated. Given the inability to easily increase sample size, one must decrease the number of variables to be measured. In assessing tactics and procedures, one way to reduce the number of variables is to collect summary performance ratings on several dimensions. If necessary, the summary ratings can be summed to yield an overall tactical and procedural score while separate ratings on each dimension still allow for the identification of strengths and weaknesses in tactics and procedures.

To this end, we developed Behavioral Summary Scales (BSS) for measuring tactical and procedural performance. BSS are similar to the well-known Behaviorally Anchored Rating Scales (BARS) with one minor exception. BARS use very *specific* descriptions of performance to anchor points along a continuum. For example, a typical BARS anchor for a college professor might be: "This instructor could be expected to assimilate the previous lecture into the present one before beginning the lecture" (Bernardin & Beatty, 1984, p. 84). BSS, on the other hand, anchor the continuum with *summary* descriptions of performance. A typical BSS anchor for an Infantryman, for example, might be: "Consistently hooks up and uses field telephone, even in the dark. Puts the radio into operation quickly, even in the dark, and enters the net properly" (MOS Performance Rating Scales [Personnel Decisions Research Institute, 1985, p. 5]). The use of behavioral anchors gives BSS an advantage over typical rating scales. Rating scales often require raters to evaluate some general characteristic of performance on a continuum (e.g., 1 to 5, 1 to 7, 1 to 9, etc.), and general adjectives are used to anchor the extreme ends of the continuum (e.g., 1 = poor performance and 9 = excellent performance).

The principle difference between BSS and typical rating scales is to direct the rater's attentions to descriptive, concrete definition of performance rather than general adjectives. In the BARS or BSS approach, these behavioral performance descriptions are used as "behavioral anchors" for the rating scale continuum. One problem with using general adjectives as scale anchors is that they are too vague. Raters may not agree with what actually defines "poor," "average," or "excellent" performance. BSS replaces general labels with behavioral anchors of "poor," "average," and "excellent" performance that are expected to increase reliability in ratings. After observing performance, raters can read the behavioral anchors and decide which anchor best describes the performance of the individual being rated. It may be that an anchor does not exactly describe the performance being rated. However, one assumes that the behavioral description more closely approximates the performance being rated than a general label.

The complete BARS or BSS development technology (Cascio, 1978) includes a job analysis activity as well as a rating scale construction process. Job analysis is conducted using the critical incident procedure to define actions and dimensions of actions that occur on a given job. The incidents are then used to write rating scale anchors indicating different levels of performance proficiency. We short-circuited the full technology by constructing scale anchors based on previous analyses. That is, instead of having subject matter

experts (SMEs) generate critical incidents, sort them into performance dimensions, and then scale the incidents, we simply wrote anchors in descriptive, summary-style terms. Our approach was patterned after the Army Research Institute's Project A rating scales (Pulakos & Borman, 1985). The anchors were then scaled by SMEs.

The identification of crew, platoon, and platoon leader evaluation criteria is described below. The identification of crew and platoon leader evaluation criteria proceeded in a comparable and somewhat simple fashion. On the other hand, platoon criteria identification progressed quite differently and in a more complex manner. Therefore, the identification of platoon evaluation criteria is described first followed by descriptions of platoon leader and crew evaluation criteria identification, respectively.

Platoon Evaluation Criteria Identification

Initially, the plan was to develop BSS for each of the platoon subordinate subtasks; however, the subordinate subtasks are very broad. During the development of potential subordinate subtask anchors, considerable overlap was observed among the criteria necessary to evaluate subordinate subtask performance. For example, subordinate subtasks generally had vehicle spacing and/or movement requirements; fire distribution was a component of several subordinate subtasks; and radio communication was involved in essentially all subordinate subtasks. Twelve common evaluation criteria were identified that can be used to distinguish performance among platoons. Table 12 presents these evaluation criteria. Table 13 shows how each criterion relates to the platoon subtask clusters and subordinate subtasks. As can be seen in Table 13, all evaluation criteria can be used to describe performance in more than one subordinate subtask, and some describe performance in every subordinate subtask. For example, Inter-Vehicular Spacing (Moving) is part of Travel in Platoon Formation, Execute Battle Drills, and Bound by Section. It is not part of any other subordinate subtask. Radio Communication, on the other hand, is an evaluation criterion within all subordinate subtasks.

Platoon Leader Evaluation Criteria Identification

Morrison et al. (1990) identified three platoon leader subtasks relevant to the gunnery process: Issue Platoon Fire Command, Request Indirect Fire, and Specify Platoon Movement. These three subtasks are essentially the summarization of a variety of tasks that the platoon leader and/or platoon sergeant perform during the course of a tactical operation. Each includes a number of subgoals relevant to a variety of situations. Each also implies a direct relationship to the platoon subtasks identified in the same report.

In defining the evaluation criteria, it became apparent that the general concept of supervision should be assessed. Each of the three subtasks implies (a) the specification of what the platoon is to do collectively, (b) monitoring individual crew performance, and (c) issuing correctives in the event that crews fail to perform as required. The later aspects, (b) and (c), include a general supervision component. This generic supervisory process was extracted from each task and defined separately. Table 14 presents the platoon leader evaluation criteria, and Table 15 outlines their correspondence to the three platoon leader subtasks identified by Morrison et al. (1990).

Table 12

Platoon Process Evaluation Criteria

Criteria	Example Measurement Operations
Inter-Vehicular Spacing (Moving)	variation from formation template; formation/technique suited to situation and modified to fit terrain*.
Inter-Vehicular Spacing (Static)	appropriate to situation*; provide visible communication and room to maneuver.
Individual Vehicle Movement	rate of movement appropriate for tactical situation; use of terrain for cover/concealment; evasive action on contact; speed of reaction and change of direction (action drill); avoidance of untrafficable terrain.
Route Selection	route/axis fits tactical situation; use of cover/concealment, speed, and reduced visibility.
Change in Formation	quickness/efficiency of change; stability of new formation.
Orientation	vehicles oriented according to formation or position; primary sectors overlap; 360° security maintained; meets readiness condition.
Position Selection	cover/concealment; observation and fields of fire; entry into positions; position suitable to tactical situation.
Intra-Position Movement	suitability of hull down, turret down, and hide positions; primary/alternate firing positions; speed of movement between firing positions; exposure time; rehearsal*; compliance with movement restrictions; use of cover/concealment.
Overwatch Effectiveness	continuity; orient on threat positions; adjust orientation according to moving element's progress*.
Direct Fire (Blue Exposed)	immediate return of fire; report timeliness; platoon reaction time; fire distribution; target sequence; volume of fire; fire lifted or shifted.
Direct Fire (Blue Hidden)	report timeliness to engagement criteria*; volume and synchronization of fire; fire distribution; target sequence; fire lifted or shifted.
Radio Communication	timeliness and brevity of transmissions; radiotelephone procedure and prowords; use of alternate means; use of security equipment.

Note. The asterisk (*) indicates aspects that should be controlled in a test situation.

Table 13

Platoon Subtask Cluster by Evaluation Criteria Matrix

	Evaluation Criteria[a]											
Platoon Subtask Clusters	1	2	3	4	5	6	7	8	9	10	11	12
Movement												
Travel in Platoon Formation												
Execute Wedge Formation	X		X	X	X	X						X
Execute Echelon Formation	X		X	X	X	X						X
Execute Line Formation	X		X	X	X	X						X
Execute Traveling Overwatch Vee Formation	X	X	X	X	X	X	X	X	X	X	X	X
Execute Column or Staggered Column Formation	X		X	X	X	X						X
Bound by Section	X	X	X	X	X	X	X	X	X	X	X	X
Overwatch a Bounding Platoon	X			X	X	X	X	X	X	X	X	
Occupy a Battle Position		X		X		X	X	X		X	X	X
Maneuver Within a Battle Position		X		X				X		X	X	X
Engagement												
Execute Battle Drills	X		X	X	X	X	X			X	X	X
Employ Firing Patterns										X	X	X
Employ Firing Techniques								X		X	X	X

[a]Evaluation Criteria:
1 = Inter-Vehicular Spacing (Moving)
2 = Inter-Vehicular Spacing (Static)
3 = Individual Vehicle Movement
4 = Route Selection
5 = Change in Formation
6 = Orientation
7 = Position Selection
8 = Intra-Position Movement
9 = Overwatch Effectiveness
10 = Direct Fire (Blue Exposed)
11 = Direct Fire (Blue Hidden)
12 = Radio Communication

Table 14

Platoon Leader Process Evaluation Criteria

Criteria	Example Measurement Operations
Fire Planning	target reference point selection; terrain appreciation; plan of attack against known or likely enemy dispositions; contingency planning (fires); documentation of defensive fire plans; integration of adjacent and/or supporting fires.
Fire Commands	timeliness, format, clarity, brevity, and precision; fire distribution; volume and control of fires.
Request Indirect Fires	suppression; integration with organic fires; screening smoke; integration with maneuver; accuracy, format, clarity, and brevity.
Operations Orders	clarity, brevity, comprehensiveness, format; scheme of maneuver's conformity with commander's intent; mutual support; cover/concealment; efficiency/effectiveness of route; contingency planning (maneuver).
Fragmentary Orders	timeliness, clarity, brevity; conformity with original plan, commander's intent, doctrine.
Supervision	degree of supervision conforms with individual crew ability; comprehensiveness of and remediation within rehearsals; attentiveness to platoon and individual crew progress; clear, concise correctives.

Table 15

Platoon Leader Subtasks and Corresponding Evaluation Criteria

Platoon Leader Subtask	Evaluation Criteria
Platoon Fire Commands	Fire Planning Fire Commands
Indirect Fire Requests	Request Indirect Fires
Platoon Movement Commands	Operations Orders Fragmentary Orders
	Supervision

Crew Evaluation Criteria Identification

The identification of crew evaluation criteria proceeded along the same lines as the platoon leader criteria identification. However, evaluation criteria were not developed for some subtasks. As pointed out in Chapter 2, the Switchology Procedures and Gun Control Manipulation subtasks identified by Morrison et al. (1990) cannot be directly evaluated by a rater.

There are training device limitations that prohibit the direct assessment of some subtasks, namely those in Switchology Procedures, Gun Control Manipulation, and Immediate Action clusters. Training devices currently used do not reliably record much of the information necessary to adequately assess performance on these subtasks. For example to measure the performance of applying immediate action to a jammed weapon, one must be able to observe the execution and the sequence of behaviors. Current recording devices are unable to capture the behavior in enough detail to yield a valid evaluation. Actual observers as used in Table VIII scoring are also unable to observe behavior in sufficient detail due to the chaotic nature of Table VIII engagements. Given current measurement capabilities, Switchology Procedures, Gun Control Manipulation, and Immediate Action are most effectively evaluated indirectly by the outcome measure target hits. Thus, no evaluation criteria were identified for these measures.

By measuring target hits, one can indirectly determine the accuracy of the switch settings. Although Maneuver Tank is a subtask requiring an outcome assessment according to the measurement specification guidelines presented in Chapter 2, it should be noted that an evaluation criterion was developed for this subtask. While being in the right position at the right time does influence target hits, it is possible to directly evaluate whether the tank was in the right place at the right time independently from target hits.

The crew evaluation criteria are presented in Table 16. The relationship between subtask clusters and evaluation criteria is shown in Table 17. Three of the subtasks, Engagement Control - Control Movement, Engagement Control - Smoke, and Maneuver Tank were integrated into one evaluation criterion labelled Movement. This was done to simplify the evaluation of tactical movement with emphasis on team performance rather than on the performance of individual crew members. The subtask, Target Acquisition, was subdivided into two evaluation criteria to differentiate between how the crew works as a team to acquire targets and how the crew manages target hand-off once one member successfully acquires a target. The remainder of the process-oriented crew tasks have a single evaluation criterion that is relatively unique to the task.

BSS Development

Methodology. After reviewing applicable training literature (Department of Army, 1986; Department of Army, 1988b; Tank Combat Tables, M1, 1986), behavioral anchors were written to describe extreme performance for each crew, platoon, and platoon leader evaluation criterion. Two additional behavioral anchors were written for each criterion which were intended to define performance between the two extremes. Each anchor was assigned an alphabetical identifier (A through D). While the four anchors for each

Table 16

Crew Process Evaluation Criteria

Criteria	Example Measurement Operations
Search Procedure	primary sector coverage; 360° security; use of optics; closed hatch searches.
Acquisition Reports	accuracy and effectiveness; timeliness, clarity, and brevity.
Fire Commands	brevity, format, accuracy; target sequencing and ammunition selection.
Subsequent Fire Commands and Engagement Procedures	progression to subsequent targets after hits; reengagement or standard adjustments after misses; accuracy of subsequent rounds; format and content of crew inter-communications.
Degraded Modes	immediate action to complete engagement; follow-up actions to isolate, correct, or compensate for fault.
Movement	use of tank's mobility, cover/concealment, and smoke; selection, movement between, and occupation of tank positions; tank commander control of movement; acceleration and braking; evasive actions; avoidance of untrafficable terrain.
Report	format, clarity, brevity, and accuracy.

Table 17

Crew Subtask Clusters and Corresponding Evaluation Criteria

Crew Subtask Cluster	Evaluation Criteria
Target Acquisition	Search Procedure Acquisition Reports
Fire Command	Fire Commands
Engagement Control - Adjust Fire	Subsequent Fire Commands and Engagement Procedures
Select Degraded Procedures	Degraded Mode
Engagement Control - Control Movement Engagement Control - Smoke Maneuver Tank	Movement
Engagement Control - Report	Reports

evaluation criterion were designed to be ordinal, the alphabetical label was seen as the best way to establish the ordinal relationship between the anchors without suggesting a specific interval between each anchor.

As previously mentioned, our behavioral anchors model the definitions used in the Army-Wide and MOS Specific Rating Scales developed for Project A (Pulakos & Borman, 1985). Therefore, all anchors within a criterion attempt to encompass all aspects of that criterion as outlined in armor doctrine. For example, the doctrinal standards for the crew criterion Search Procedure include (a) searching between engagements, (b) primary sector coverage and 360° security, (c) crew members searching their entire sectors, (d) making detailed searches of danger areas, (e) use of binoculars or night vision goggles, and (f) loader's use of his periscope. Therefore, all four anchors for Search Procedure encompass each of these aspects.

A workshop was conducted to complete final development of the BSS. Four NCOs (three E-6s, one E-7) served as SMEs. The NCOs work as instructor/writers for either the Weapons Department or the Command and Staff Department of the Armor School, which have primary responsibility for the development of gunnery and tactical doctrine/training, respectively. SMEs were first asked to assign numerical values to the performance anchors. Anchors were randomized within an evaluation criterion so that anchor A did not always reflect good performance and D poor performance or vice versa. Using a scale of 1 (extremely ineffective performance) to 9 (extremely effective performance), SMEs were asked to independently indicate the quality of performance described by each anchor. The rating scale was intentionally vague to allow SMEs maximum leeway in assigning their ratings.

While making their ratings, participants were asked to look for any irregularities in the content of performance anchors. Specifically, SMEs were to note any material that should be added or deleted from an anchor and to indicate any necessary revisions. After completing their ratings, the group discussed errors found in the performance anchors and worked toward a consensus decision of appropriate modifications.

Results. Generalizability analyses (Brennan, 1983; Cronbach, Gleser, Nada, & Rajaratnam, 1972) were conducted to examine rater agreement. The analytic design has raters (R) crossed with performance anchors (PA; each rater rated each performance anchor) with performance anchors nested within evaluation criteria (EV) (i.e., R x (PA:EV)). Performance anchors are the objects of measurement and raters the measurement instrument; thus, variance from performance anchors (nested within evaluation criteria) and variance from evaluation criteria are considered true score variance. Rater variance (i.e., main effects) and variance from interactions with raters are considered sources of error. Performance anchors and evaluation criteria are fixed effects; raters are random.

Variance components and single rater generalizability coefficients are presented in Table 18. Across the board, interrater reliability was high. Based on the single rater estimates, expected reliabilities from four raters would all be .95 or higher. To a large extent this may have been due to the demand characteristics of the rating task. For each evaluation criterion, four obviously different anchors, two of which represented extremes in performance, were to be spread across a nine-point scale. Thus, one would expect near perfect agreement in the ordering of the anchors with little room to vary on the assignment of numerical values. As a result error variance due to raters was very low, true variance due to the anchors themselves was high, and consequently reliability was high.

The group discussion of the evaluation criteria and their anchors identified some doctrinal errors in our anchors. These errors were corrected according to SME direction. In addition, crew and platoon evaluation criteria were reorganized extensively. The reorganization of crew evaluation criteria increased the number of rating scales from six to eight, whereas platoon criteria reorganization decreased the number of scales from 12 to 8. The correspondence of the reorganized rating scales to the crew and platoon subtask clusters are presented in Tables 19 and 20, respectively. Because platoon leader criteria were not reorganized, evaluation criteria correspondence to platoon leader subtasks remain as presented in Table 15.

More important than either the reliability or doctrine correcting results, the group discussion revealed extreme dissatisfaction with the BSS format. The primary problem seemed to lie in a reluctance to transfer from a simple checklist format to a summary rating scale. SMEs were concerned about the number of aspects covered in each anchor. For example, the anchors for Direct Fire (Blue Hidden) address seven aspects of that evaluation criterion. SMEs were confused as to how an evaluator would rate a platoon that performs two of those aspects exactly as described in the most effective anchor and the other two exactly as described in the most ineffective anchor.

Table 18

Variance Components and Generalizability Components Expressed as Interrater Agreement for Proposed Evaluation Criteria Performance Anchors

Source of Variance	Level of Measure: Crew	Platoon	Platoon Leader
Rater	.03	.13	.15
Evaluation criteria	.28	.21	.0
Anchor:Evaluation criteria	8.34	8.22	11.25
Rater x Evaluation criteria	.23	.21	.16
Rater x Anchor: Evaluation criteria	1.40	1.56	.70
Generalizability Coefficient	.84	.81	.92

Note. Evaluation criteria and anchors are fixed; raters are random. Generalizability coefficients include rater main effects and interactions as error variance.

Table 19

Crew Subtask Clusters and Corresponding Evaluation Criteria - Revised

Crew Subtask Cluster	Evaluation Criteria
Target Acquisition	Search Procedure Acquisition Reports
Fire Command Engagement Control - Adjust Fire Select Degraded Procedures	Normal Mode Fire Commands and Reengagement Degraded Mode and Subsequent Fire Commands
Engagement Control - Control Movement Engagement Control - Smoke Maneuver Tank	Movement Reaction Drills
Engagement Control - Report	Contact Reports Spot Reports

Table 20

Platoon Subtask Cluster by Evaluation Criteria Matrix - Revised

	Evaluation Criteria[a]							
Platoon Subtask Clusters	1	2	3	4	5	6	7	8
Movement								
Travel in Platoon Formation								
Execute Wedge Formation	X	X				X		X
Execute Echelon Formation	X	X				X		X
Execute Line Formation	X	X				X		X
Execute Traveling Overwatch Vee Formation	X	X				X		X
Execute Column or Staggered Column Formation	X	X				X		X
Bound by Section	X	X				X		X
Overwatch a Bounding Platoon			X			X		X
Occupy a Battle Position			X	X	X			X
Maneuver Within a Battle Position				X				X
Engagement								
Execute Battle Drills			X					X
Employ Firing Patterns							X	X
Employ Firing Techniques							X	X

[a]Evaluation Criteria
1 = Route Selection
2 = Movement
3 = Position Selection
4 = Intra-Position Movement
5 = Orientation (Defense)
6 = Orientation (Offense)
7 = Direct Fires
8 = Communication

Rating Scale Revision

As argued earlier, a summary rating is more practical than a binary checklist for statistical purposes. Given the number of crews, platoons, and platoon leaders typically available for testing, a binary checklist provides too many discrete bits of information for meaningful statistical analyses. On the other hand, it is impractical to implement a summary rating scoring procedure if it is adamantly opposed by those who will employ it. In an attempt to reconcile differences between that which is desirable from a statistical perspective and that which is agreeable to evaluators, we developed behavior description rating scales by combining the BSS and checklist formats.

Rather than include all aspects of an evaluation criterion in each performance anchor, the behavior description scales present the aspects in a bullet format. A five-point rating scale is provided for each bullet. As an example, the rating scale for Fire Planning, a platoon leader evaluation criterion, is shown in Figure 21. Appendix B presents the final scales for all crew, platoon, and platoon leader evaluation criteria. As can be seen in Figure 21, a general definition of the evaluation criterion is given. Following the general definition are rating scales for several behaviorally descriptive aspects of the criterion. Ratings for the aspects can be averaged to yield an overall rating for the evaluation criterion. A composite rating for each evaluation criterion keeps to a minimum the number of variables being analyzed while retaining the ability to identify specific tactical and procedural strengths and weaknesses. Of more importance, evaluators find the revised rating format acceptable. SMEs who participated in the BSS development workshop were asked to review the revised behavior description rating scales. All indicated a preference for the revised format. A primary source of discontent with the original BSS format was the inability to precisely indicate strengths and weaknesses in the performance of various aspects of an evaluation criterion. SMEs felt that the revised format enabled them to indicate these performance differences more precisely than the original BSS.

The revised behavior description scales may appear to be a step backward in terms of rating scale technology; however, they are not. Rating scale research results indicate that the specific format is secondary in importance to the use of behavioral descriptions of performance (Kingstrom & Bass, 1981). While the revised scales do not behaviorally define the numbers on the scale and evaluators must decide what is meant by "rarely," "often," etc., behavioral descriptions of performance are retained in the stem of what is to be rated.

Rater Training Program

A rater training program which concentrates on scale content and rater error training was also developed. The rater training program is presented in Appendix C. Because the gunnery evaluator will be an armor expert, he is expected to be familiar with the various facets subsumed under each evaluation criterion. However, being familiar with and knowing exactly which facets are included are two different matters. Given the number of rating scales to be completed and that much is happening at any one time during a gunnery exercise, an evaluator must be extremely familiar with (i.e., know) the performance subsumed under each evaluation criterion. Knowing all aspects of performance to be rated enables the evaluator to attend to those behaviors covered by the rating scales and ignore those that are not.

The rating scales seem to be simple and straightforward; however, the scales are to be completed after several engagements or an entire exercise. From an evaluator's point of view, there is a lot of information to remember and integrate across several engagements. Consider, for example, the position of a platoon evaluator. When a platoon conducts a gunnery exercise, not only is an evaluation of the platoon required but also an evaluation of the platoon leader. There are eight platoon scales and six platoon leader scales. Thus, the evaluator must complete 14 rating scales for each platoon exercise.

FIRE PLANNING

The platoon leader/platoon sergeant (Pldr/PSG) orients the platoon to the terrain (e.g., points out key terrain and avenues of approach), designates individual vehicle positions (i.e., primary and supplemental), and sectors for each vehicle position. He designates direct fire control measures (e.g., TRPs, engagement areas) to partition the platoon sector and to provide for mutual support both within the platoon and with adjacent platoon elements. The Pldr/PSG establishes engagement criteria for the platoon. He establishes standing fire patterns and firing techniques based on likely enemy actions. Time permitting, the Pldr/PSG consolidates a platoon fire plan. He verifies that individual crews/crew members understand the platoon fire plan, how their tank supports the platoon plan, and are properly oriented to the terrain.

Rating Scales

	Never	Rarely	Some-times	Usually	Always	Not Observed
The Pldr/PSG orients the platoon to the terrain.	1	2	3	4	5	NO
The Pldr/PSG designates primary and supplemental positions for each tank.	1	2	3	4	5	NO
The Pldr/PSG designates individual sectors for each primary and supplemental vehicle position.	1	2	3	4	5	NO
The Pldr/PSG designates direct fire control measures appropriate to the tactical situation.	1	2	3	4	5	NO
The Pldr/PSG plans for mutual direct fire support both within the platoon and with adjacent platoons.	1	2	3	4	5	NO
The Pldr/PSG documents the platoon fire plan if time permits.	1	2	3	4	5	NO
The Pldr/PSG verifies sector coverage from turret down and hull down positions.	1	2	3	4	5	NO

Figure 21. Fire planning rating scale.

To aid evaluators in making summary ratings, a worksheet was designed for each engagement. A sample worksheet is presented in Figure 22. The worksheet lists the evaluation criteria which are applicable for the given engagement and summary statements about the behavior covered by each criterion. A legend is provided to assist the evaluator in making summary notes regarding the ratee's performance on facets within each evaluation criterion. Additional space is provided for the evaluator to make handwritten notes of the ratee's performance. Upon completion of the exercise, the evaluator can refer to his completed worksheets when assigning ratings. For example during the course of an exercise, the evaluator observes the platoon communicate via the radio five times. The behavior is performed satisfactorily four times and unsatisfactorily only once. Upon completion of the exercise, the evaluator consults his worksheets and determines that four of five satisfactory performances relates to "usually" on the rating scale. For Communication, he assigns the crew a rating of "4" for the entire exercise.

Rater training also focuses on error reduction and accuracy training similar to the program developed for Project A (Pulakos & Borman, 1985). Thus, it describes four errors raters typically make: (a) halo error, (b) same-level-of-effectiveness error, (c) one-incident-of-performance error, and (d) stereotyping. Although evaluators are urged to avoid making these errors, the program reminds them that their primary duty is to provide accurate ratings. Thus, if evaluators feel that a crew, platoon, or platoon leader performs at the same level in several categories (halo error) or that several ratees perform at the same level within a category (same-level-of-effectiveness error), they are instructed to reflect these "errors" in their ratings.

The rater training program also provides an opportunity for evaluators to practice using the worksheets and assigning ratings. Descriptions of two crew and two platoon engagement performances are presented in the training program (Appendix C). Evaluators use the worksheets to make notes regarding engagement performance. Using the worksheets, evaluators independently provide summary ratings across the two engagements for the crew, platoon, and platoon leader. As a group, they then discuss their ratings. Any questions regarding the use of the worksheets, the performance aspects covered by each rating scale, rating errors, etc. are answered.

Summary

In this chapter, rating scales have been presented to support assessment of some of the "process" aspects of crew and platoon gunnery. In two rather major respects, the final scales do not resemble our initial expectations. First, initial plans called for development of scales to mirror the subtasks developed by Morrison et al. (1990) presented in Chapter 2. Instead, final scales were developed to address a set of "evaluation criteria" that seem to underlie those subtasks. Particularly for the platoon level of assessment, many of the evaluation criteria represent aspects of performance that apply to more than one subtask. In other words, they represent an alternative way to structure the gunnery performance domain that eliminates some of the redundancy in the subtask structure. The second major change is in regard to scale format. In the development workshop, SMEs indicated that the summary

ENGAGEMENT 6. TANK PLATOON ATTACK AGAINST THREAT MEETING ENGAGEMENT

CONDITIONS. The threat second echelon regiment attack has been defeated. The battalion-task force and company-team are resuming their attack to the west. The exercised platoon has consolidated behind the original LD/LC and is now attacking along AXIS RICK through CP 1 and CP 2. The remainder of the company team cannot cover their move. The platoon encounters a motor-rifle company(-)(advance guard) between CPs 1 and 2. As the engagement proceeds, an adjacent platoon moves into position and engages the northern half of the array.

Evaluation Criteria: Pldr/PSG
Observation codes: + = good; o = o.k.; - = bad (leave blank if not observed).

FIRE PLANNING
___Orients platoon to terrain.
___Designates tank positions.
___Designates primary sectors.
___Provides for mutual support.

FIRE COMMANDS
___Uses clear, brief fire commands.
___Uses suitable fire pattern/ technique.
___Issues effective fire commands.

FRAGMENTARY ORDERS
___Uses only when req'd to refine/ modify plan.
___Conforms with cdr's intent.
___Uses clear, brief, timely FRAGOs.

REQUEST INDIRECT FIRES
___Makes clear, brief, accurate calls for fire.
___Uses FA/Mort to suppress or to reinforce direct fires.
___Uses indirect smoke effectively.
___Coordinates FA/Mort with plt movement and fires.

SUPERVISION
___Monitors/corrects subordinates during execution.
___Issues clear, brief, specific correctives.
___Uses situational leadership.

NOTES.

Figure 22. Sample engagement worksheet.

ENGAGEMENT 6. TANK PLATOON ATTACK AGAINST THREAT MEETING ENGAGEMENT

Evaluation Criteria: Platoon
Observation codes: + = good; o = o.k.; - = bad (leave blank if not observed).

ORIENTATION (OFFENSE)
___Orients on primary threat.
___Tanks orient per formation.
___Maintains internal/external mutual support.
___Provides continuous overwatch.
___Shifts orientation per moving element.
___Returns fire on contact.
___Reports contact immediately.
___Executes appropriate drills immediately on contact.

ROUTE SELECTION
___Uses appropriate route.
___Uses cover & concealment.
___Uses reduced visibility.
___Avoids untrafficable terrain.

MOVEMENT
___Uses suitable movement technique/formation.
___Maintains stable formation.
___Adjusts formation to terrain.
___Uses suitable movement rate.
___Bounds don't outrun overwatch.
___Changes direction/formation quickly.

INTRA-POSITION MOVEMENT
___Tanks properly occupy positions (hide, turret-, hull-down).
___Tanks coordinate movement, fires.
___Tanks maximize exposure: hull down.
___Tanks avoid AT fires.
___Tanks use speed, covered and concealed routes between positions.

DIRECT FIRES
___Distributes fires effectively.
___Complies with higher fire distr.
___Engages per target classification.
___Engages per target range.
___Uses suitable volume of fires.
___Shifts/ceases fires when suitable.

COMMUNICATIONS
___Crews use proper RTP.
___NCS maintains network discipline.
___Crews transmit clear, brief msgs.
___Uses COMSEC equipment.
___Uses visual communication.
___Crews transmit timely, accurate messages.

NOTES.

Figure 22. Sample engagement worksheet (continued).

level BSS format was unacceptable. Therefore, the format was revised. Behavior description rating scales with frequency anchors were developed to replace the BSS.

Finally, a rater training program was prepared to provide instructions to the raters who will use these scales to evaluate crew, platoon, and platoon leader gunnery activities. The rater training program consists of (a) a review of each BSS to ensure that raters know the exact behaviors to be rated, (b) instruction on typical rating errors and how to avoid making them, and (c) a practice session during which raters use the engagement worksheets to provide ratings.

Chapter 5. Standard Setting Approaches for Gunnery Process

The previous chapter presented a number of rating scales on which to assess gunnery procedures. These scales provide the basic data needed to evaluate various training strategies and devices. In this chapter, we address the issue of setting performance standards on these scales. Although we declined the opportunity to set standards for gunnery speed and accuracy, standards for the process ratings are much less political and much easier to acquire. Therefore, standard setting for the process rating scales is pursued. Although such standards are not essential for differentiating the performance that may result from different amounts and types of training, they are informative when examining single sample distributions and case studies. Aside from research purposes, information provided by performance standards is highly desired by score users (i.e., instructors, students, commanders, etc.). With speed and accuracy, score users have a general idea of the relationship among scores. That is, users understand that a crew that hits three of three targets in 20 seconds is "better" than one that hits two of three targets in 30 seconds. While they may make errors in comparing scores across differences in the number of targets presented, score users still have a general idea of how speed and accuracy scores differentiate performance among crews or platoons. Ratings, on the other hand, are not so easily interpreted because they are made against an abstract scale with less inherent meaning. Assigning standards to a rating scale therefore adds meaning to otherwise intangible scale numbers.

This chapter begins with a review of a number of special considerations for rating gunnery procedures. Next we review selected traditional standard setting methods as they are applicable for setting performance standards on our process measures and propose two standard setting methods.

Considerations Affecting Standards for Gunnery Research

None of the traditional standard setting methods require judges to examine tests as a whole; rather SMEs are required to consider individual items and use some sort of computations to aggregate up to the test level. For the gunnery test that we have been unfolding in this paper, it is not clear for standard setting purposes what a test item is. An exercise is composed of several engagements. Process performance for each engagement can be assessed by summing or averaging facet ratings for one or several evaluation criteria. Thus for any exercise, an item could be a particular engagement, a particular evaluation criterion, or a particular facet within an evaluation criterion. In essence, it is all three. For process measure standard setting purposes, we will consider two levels of test items: (a) the facets within an evaluation criterion and (b) the evaluation criteria included in a gunnery test. The evaluation criteria are to some extent exercise specific. For example, an offensive platoon exercise will not require rating the platoon's performance on Orientation (Defense). Therefore, the overall goal is to obtain a standard for each evaluation criterion.

Another issue concerns the number of levels of standards desired. Is a single pass/fail cutoff appropriate, or would several levels of performance standards be more beneficial? In many testing situations, several levels of performance are defined with performance below a certain point deemed unacceptable. In education for example, 90% correct or greater is often

regarded as outstanding, 80% to 89% correct is superior, 70% to 79% correct is acceptable, and 69% correct or below is unacceptable. Although not explicitly stated, one purpose of various levels of performance is to encourage individuals to strive for improvement. Because the goal in war is to be better skilled than the enemy, crews should never be encouraged to "rest on their laurels" once they have met the minimum performance standard. In maintaining crew skills, the goal should be to strive for perfection. For these reasons, the procedures described below will establish standards to differentiate proficiency levels above being simply qualified. The four category scheme used in Tables VIII and XII provide appropriate labels: unqualified, qualified, superior, and distinguished performance.

As mentioned previously, the goal is to establish standards for each evaluation criterion. Given the format of the behavior description scales, one must decide whether to (a) set standards on each evaluation criterion or (b) set standards on each facet and sum or average those facet standards to reach a standard on the evaluation criterion. Either procedure will probably yield insignificantly different standards; however, there may be vital differences from the perspective of the SMEs. In the Behavioral Summary Scale (BSS) development workshop described in Chapter 4, SMEs rejected a scale format requiring a summary rating on each evaluation criterion in favor of one requiring a rating for each facet within an evaluation criterion. In their discussion, SMEs stressed criticality differences among facets within an evaluation criterion. They felt that by rating each facet of an evaluation criterion they could be stricter in their assessments of the more critical facets. Based on this rationale, it is unlikely that SMEs would accept the notion of setting standards at the evaluation criterion level. They would prefer to be able to differentially set standards depending on the criticality of the facets. If standards are to be set at the evaluation criterion level, the standard setting instructions must be written to "sell" the idea of standard setting at the criterion level as opposed to the facet level.

In deciding whether to set standards at the evaluation criterion level versus the facet level, one must consider the time and effort required by each procedure. As mentioned previously, the goal is to establish four levels of performance: distinguished, superior, qualified, and unqualified. To accomplish this goal, three cutoff ratings must be identified. (Any rating below the qualified cutoff is considered unqualified.) While SME acceptance is important, setting three standards for each facet is time consuming and repetitious. Given the five-point rating scales, it is unlikely that the cutoff ratings for distinguished, superior, and qualified performance will vary a great deal across facets or even across evaluation criteria. Thus, the outcome seems hardly worth the effort.

An equally important consideration is the performance definition against which standards will be set. Performance definitions describe, in concept, what it means for a tank crew, platoon, or platoon leader to be distinguished, superior, qualified, or unqualified. The question is whether the definition should be provided by researchers or by the SMEs. While no research could be found to demonstrate the superiority of either researcher- or rater-generated performance definitions, it seems prudent to begin the session with performance defined by the researcher. If the definition is completely out of line, raters can enhance it with the guidance of the researcher. If more than one workshop is to be conducted, the definition can be corrected at the first workshop. The corrected definition can then be used in subsequent workshops.

The identification and utilization of qualified experts is perhaps the most important consideration in any standard setting procedure. Provided they are qualified, research results in the field of education indicate that different groups of judges from a variety of backgrounds provide similar standards. In addition, standards are more readily accepted if they are set by qualified judges from a diversity of backgrounds (Andrew & Hecht, 1976; Jaeger, 1982). Employing a variety of judgmental standard setting procedures, the U.S. Army's Synthetic Validity Project used NCOs and Officers from FORSCOM and TRADOC commands in an attempt to survey experts with a variety of experiences. While Officers had slightly more reliable ratings, there were no other appreciable NCO versus Officer or FORSCOM versus TRADOC differences (Peterson, Owens-Kurtz, Hoffman, Arabian, & Whetzel, 1990). Thus, using a judgmental method, either NCOs or Officers from FORSCOM or TRADOC could be used. However, restricting the diversity of SMEs raises the issue of standard acceptability. If the test and resulting standards are to be used at both FORSCOM and TRADOC sites, it is prudent to survey SMEs from both commands. The central issue here may be summarized by the question: Who are to be the users of the research results, and are they represented?

In addition to obtaining SMEs from diverse experiences, one must decide on the optimal number of judges. The optimal number of judges is determined to some extent by psychometric considerations, to some extent by the standard setting method employed, and to some extent by the number of qualified SMEs available. The number of judges is positively correlated with the reliability of the standard and negatively correlated with the amount of dispersion in the standard (Pulakos, Wise, Arabian, Heon, & Delaplane, 1989). Jaeger and Keller-McNulty (1986) suggest determining the necessary number of SMEs based on reductions of the standard error of the test standard and the standard error of measurement of the test. Cross, Impara, Frary, and Jaeger (1983) and Jaeger and Busch (1984) found that psychometric considerations are maximized with sample sizes of 20 to 30.

The standard setting method often imposes practical constraints when determining the optimal number of SMEs. Methods implementing convergent discussions necessitate small- to medium-sized groups to prevent a few dominant SMEs from exerting too much control over other judges' decisions. Workshops with 20 participants are practical, but more than 20 participants tend to be unmanageable.

Proposed adaptations of traditional judgmental standard setting methods are presented below along with explanations regarding their appropriateness for the present purposes. Recall from Chapter 4 that behavior description rating scales were developed to assess tactical and proficiency performance for a crew, platoon, and platoon leader. Therefore, instead of identifying "cutoff scores" to differentiate distinguished, superior, qualified, and unqualified performance, the term "cutoff rating" will be used. Also recall from the above discussion that the evaluation criteria included in a gunnery test will ultimately be considered as the test items. Any of the proposed adaptations described below could be used to set standards on each evaluation criterion or on each facet. Because the time and effort required to set standards on each facet seems wasteful, our proposed adaptations will establish three levels of performance standards for each evaluation criterion.

Application of Traditional Standard Setting Methods to Gunnery Process Measures

Most literature on standard setting comes from education where the primary concern is with setting minimum competency standards on written tests. Although Jaeger and Keller-McNulty (1986) suggest that the methods used to establish standards on written tests can be modified for use with performance tests, essentially no research has attempted to apply these techniques to performance tests. The following is a brief review of traditional standard setting procedures as they might apply to our process measures. More comprehensive reviews can be found by Pulakos et al (1989) and by Jaeger and Keller-McNulty.

Standard setting procedures can be divided into two categories: (a) judgmental and (b) empirical. Judgmental methods require that raters make judgments regarding the proportion of minimally competent individuals who would correctly answer each test item. Proportions are aggregated across items and judges to form a "percent correct" standard. Empirical methods require that raters identify competent and noncompetent or borderline competent individuals who are then administered the test. Standards are then set based on the data obtained from the test administration. A primary disadvantage of the empirical methods is that the cost of administering the test as a prerequisite for setting standards is likely to be infeasible, especially for performance tests. It is possible to circumvent a separate, and potentially expensive, test administration by using data from the first test administration to establish performance standards. In this case, standards are not known prior to the first test administration. While this may be a less expensive solution, it is difficult to convince lay persons of the credibility of standards set in this fashion. Because of their infeasibility, empirical methods will not be further discussed.

One overriding concern in selecting a standard setting procedure is that the procedure should be easily implemented and understood by the raters. If the procedure requires raters to make decisions that go beyond their expertise, they will feel uncomfortable with the resulting standard. Consequently, they will be unlikely to implement the standard. The general consensus is that the Angoff method is the most easily understood (Poggio et al., 1981; Poggio, 1984). The Angoff method as well as the Ebel and Jaeger methods, with their suggested modifications, appear to be feasible for setting standards on our gunnery process rating scales. The Angoff and Ebel methods are conceptually similar: judges are asked to estimate the performance of minimally competent performers. The Jaeger method presents a slightly different concept: judges are asked to indicate the lowest acceptable level of performance. Consideration of these three approaches will continue.

Adaptation of the Angoff Method

The traditional Angoff method requires raters to think of a group of minimally competent individuals and then estimate the percentage of those individuals who would be able to answer each item correctly. The cutoff score for a particular rater is the average of his or her percentages across items. The test standard is the average of cutoff scores across raters. Thus, the percentage of minimally competent individuals passing an item is converted to the percentage of items that should be passed by minimally competent

individuals. Compared to other standard setting procedures, the Angoff method is the most straightforward and the easiest to implement. Raters have essentially no problem understanding the task they are to perform.

Our decision to set standards for three levels of performance complicates our adaption of the Angoff question. For a single cutoff score that differentiates two groups, the question concerns the average, or expected, rating for minimally competent individuals (i.e., those persons just barely into the qualified category). To obtain three cutoff ratings to differentiate unqualified, qualified, superior, and distinguished performers, the following questions are appropriate:

1. What is the expected rating for a group of minimally *qualified* persons?

2. What is the expected rating for a group of minimally *superior* persons?

3. What is the expected rating for a group of minimally *distinguished* persons?

Obviously, the wording for the second and third questions sounds incompatible. Given the importance of rater understanding and acceptance, the modification of this method is unsatisfactory. Certainly, the concept and logic of the questions could be explained. The simplest explanation seems to be that the rating we are after is the lowest rating for a particular category of persons. This explanation is not sufficiently different from the concept of the Jaeger derived question, which is presented below, to justify using both methods. Therefore, no further attention is given to attempting to set performance standards using an Angoff based approach.

<u>Adaptation of the Jaeger Method</u>

Poggio (1984) points out that many raters have difficulty determining the percentage of examinees who should correctly answer each item. The Jaeger method circumvents that problem by having raters answer a yes/no question. Instead of trying to estimate the performance of minimally competent individuals, judges are asked to consider the following question: "Should *every* examinee in the population of those who receive favorable action on the decision that underlies use of the test be able to answer the test item correctly?" (Jaeger & Keller-McNulty, 1986, p. 14). In other words, should every person who is at least a minimally competent examinee be able to answer this item correctly? A "yes" response is scored as 1, and a "no" response is scored 0. A cutoff score for each judge is calculated by summing his or her "yes" responses across items. The test standard is determined by computing the median cutoff score across judges.

In an attempt to reduce the variability in standards, the Jaeger method prescribes an iterative approach and the use of normative data. After setting initial standards, judges are told the percentage of examinees who actually answered each item correctly on a recent administration of the test. Upon reviewing the data, judges are asked to reconsider their recommendations and again independently answer the same question for each item. In preparation for the final rating phase, judges are told the percentage of examinees who

would have failed the test on a recent administration given the group's second standard. The distribution of cutoff scores recommended by fellow judges during the second phase is also presented. Judges once again answer the same yes/no question, and the median standard for the group from this final phase becomes the test standard.

Our suggested adaptation of the Jaeger method offers a straightforward approach to setting standards on a continuous scale. To obtain three cutoff ratings, the following questions must be asked:

1. What is the minimum rating a crew, platoon, or platoon leader could obtain to be considered *qualified*?

2. What is the minimum rating a crew, platoon, or platoon leader could obtain to be considered *superior*?

3. What is the minimum rating a crew, platoon, or platoon leader could obtain to be considered *distinguished*?

SMEs would review the behavior description scales to get an idea of the facets covered by each evaluation criterion. They would then identify the rating cutoffs for each evaluation criterion or for each facet within evaluation criteria by answering the questions presented above. At the level of the facet, the five-point rating scale constrains the ability of SMEs to differentiate the levels of performance. It is quite possible that SMEs will indicate that a rating of "3" will be the cutoff rating for qualified, a "4" for superior, and a "5" for distinguished. SMEs could rate total points for each evaluation criterion so that even for evaluation criteria that have only three facets, total possible points spread from 3 to 15 thus allowing greater flexibility is assigning cutoff ratings to the different performance levels.

An iterative process could be incorporated to examine the effects of a convergent discussion on the amount of variability in the standards. That is, after providing initial cutoff ratings, participants would discuss the rationale for their ratings. Specifically, highly discrepant ratings would be discussed in an attempt to reduce the variability in rating cutoffs. The goal of the discussion is for the participants to reach a convergent decision regarding their ratings. In other words, SMEs would be encouraged to reach a general agreement regarding the ratings, but a unanimous decision would be neither expected nor encouraged. Following the discussion, SMEs would repeat the standard setting process. SME cutoff ratings from the final standard setting phase would be averaged for each evaluation criterion. The average rating cutoffs from the final phase would serve as the standards.

Adaptation of the Ebel Method

The Ebel method requires SMEs to first classify test items on two dimensions: (a) difficulty and (b) relevance. Ebel suggests three levels of difficulty (easy, medium, and hard) and four levels of relevance (essential, importance, acceptable, and questionable). However, the dimensions and number of levels can be changed without altering the basic method. After considering each item on the two dimensions, SMEs working independently allocate each item to 1 of the 12 cells formed by the 3 (difficulty) x 4 (relevance) matrix. For example, item 1 might be judged to be "easy" and of "questionable relevance", item 2 might be judged to be "hard" and "essential", etc. Working as a group,

SMEs then decide the percentage of items in each of the 12 cells a minimally competent examinee would be able to correctly answer. For example, minimally competent examinees might be expected to correctly answer 90% of the "easy and essential" items, 20% of the "hard and questionable" items, etc. Thus, while the Angoff method requires SMEs to judge each item, the Ebel method dictates that SMEs categorize items and then judge the categories.

For each SME, the number of items in a particular cell is multiplied by the percentage assigned to that cell. These products are summed across cells to yield a cutoff score for each SME. The average cutoff score across SMEs becomes the test standard. Thus, the assignment of items in the matrix does not directly affect computation of cutoff scores. Rather, the matrix is a guide to assist SMEs in making their ratings.

The modified question for making the Ebel method compatible with continuous rating is the same question suggested for the Angoff method. Therefore, the Ebel method is also on tenuous grounds. Before it is dismissed completely, the merits of categorizing evaluation criteria should be considered.

The Ebel standard setting method takes advantage of the unique item-within-an-item characteristic of the evaluation criteria. There are a total of 127 facets across the crew, platoon, and platoon leader evaluation criteria. To allow SMEs to differentiate facets without having to rate each facet, the Ebel classification scheme could be applied. That is, within each evaluation criteria, facets could be classified by difficulty and importance and then standards set by category. Given that there are approximately six facets per evaluation criteria, the number of potential categories cannot be as large as Ebel's suggested 3 x 4 matrix. To reduce the number of standard setting ratings, facets would need to be classified into a 2 (difficulty) by 2 (importance) matrix with difficulty and importance levels defined as high and low or into a three level importance array, omitting the difficulty dimension. SMEs would independently assign facets to a matrix for each evaluation criterion. Standard setting would then be accomplished for each cell by asking the modified Jaeger question presented above.

Working separately by performance level and SME, the number of items in a particular cell would be multiplied by the average rating assigned to that cell. In other words, the number of items in a particular cell would be multiplied by the average rating for distinguished performers assigned to that cell. For that same cell, the number of items would then be multiplied by the average rating for superior performers assigned to that cell then by the average rating for qualified performers assigned to that cell.

The sum of products by performance level would yield a standard for each SME and each evaluation criterion. For each evaluation criterion, the average distinguished, superior, and qualified rating cutoff would be calculated across SMEs. The final standards would be obtained by averaging the rating cutoffs across SMEs for each evaluation criterion.

Recommended Approach

It is our recommendation that standards should be set using the modified Jaeger questions for the three levels of performance. The only remaining issue is whether to have SMEs set standards for each facet, for categories of facets, or for total scores on the evaluation criteria. Each has its advantages and disadvantages. Setting standards for each facet allows SMEs to adjust for perceived differences in facet criticality, but the five-point scale limits the ratings. Standards for the evaluation criteria would be computed from the facet ratings. The second option, setting standards on categories of facets, also allows SMEs to account for differences in criticality, and working with total facet score per category expands the scale. However, this requires an extra step; the facets must be sorted into categories. Also, some of the facets may end up as the only member of a cell. Standards for the evaluation criteria would be computed from the facet category ratings. The final option is to have SMEs directly set evaluation criterion standards. This approach does not allow SMEs to explicitly differentiate the criticality of the separate facets, but it does provide a longer scale which allows more freedom for assignment of cutoff values.

The step of sorting facets prior to setting standards appears not to provide sufficient benefit for the effort. Therefore, the Ebel sorting method is eliminated. The other two options, setting standards at the facet level and at the evaluation criterion level, will be combined. SMEs will first be given the performance level descriptions. Then, working with one evaluation criterion at a time, SMEs will work though the following steps.

1. For each facet, indicate the minimum score for qualified, superior, and distinguished performance levels.

2. For each of the performance levels, sum the cutoffs rating across the facets. The result will be initial cutoffs in terms of total evaluation criterion scores.

3. Review the total score cutoffs and make adjustments to fine tune differences between performance levels.

4. Conduct a consensus building discussion for the standards set on the evaluation criteria. Repeat the rating of the evaluation criteria standards.

These steps are to be repeated for each evaluation criterion. Steps 1 and 2 allow SMEs to consider differences in facet criticality to guide making evaluation criteria cutoffs. Step 3 extends the scale so that SMEs are not constrained to put three cutoffs on a five-point scale, and it eliminates the researcher's step of calculating evaluation criteria cutoffs from the facet level cutoffs. The fourth step allows discussion and group feedback to be conducted for the evaluation criteria cutoffs without having to address each facet within the criteria. These procedures are completely laid out in Appendix D.

Summary

The development of standard setting methods originated with a need to establish minimum performance standards for written tests. Early work was centered in the field of education where methods were developed to set standards on tests consisting of dichotomously scored items. Little research has been conducted regarding the development of new methods or the application of traditional methods for establishing standards for performance tests. Even less has been done to adapt traditional methods for establishing standards on tests comprised of continuously scored items. It is generally assumed that traditional standard setting methods can be adapted for use with performance tests and with continuously scored items.

The evaluation criteria developed in Chapter 4 for scoring gunnery processes consist of several continuous rating scales. Assuming that traditional methods are applicable to performance tests and can be adapted for use with a continuous rating scale, three adaptations were suggested: (a) Angoff, (b) Jaeger, and (c) Ebel. Jaeger and Ebel adaptations seem to be the most viable for performance measures in general. Because of the particular structure of our evaluation system (e.g., multiple evaluation criteria with ratings on a small number of facets per criterion), the Ebel sorting approach does not appear to be advantageous. The resulting method then is basically an adaptation of Jaeger. This adapted method will directly provide the needed cutoff scores for each evaluation criterion, provide SMEs a mechanism to explicitly consider differences in facet criticality, and allow a manageable feedback discussion session.

Chapter 6. Devices and Equipment for the Gunnery Criterion Components

The eight components of the gunnery criterion test were presented in Chapter 1. These components represent all of the combinations of skill echelon (crew or platoon) by target base (Combat Table or threat-based arrays) by firing mode (live fire or instrumented dry fire). These components were selected to insure adequate coverage of the domain of tank gunnery, given the restriction that the criterion test should be conducted using only on-tank experiences. Thus, devices such as SIMNET, U-COFT, or the new P-COFT are not considered for inclusion in the test. To augment live fire, we suggest using "instrumented dry fire." This section explores the particular instruments that may be used to obtain valid test results. Both available and nearly available options are discussed.

Interacting with the live fire/dry fire distinction is the selection of range facilities. More engagement possibilities exist with dry fire, but the differences between live fire and dry fire in range facility requirements are not trivial. In addition, instrumentation options differ in the type and amount of data they capture or allow to be captured. Thus, the ground on which the test is conducted and the instruments for obtaining the performance data are both important issues.

The instrumentation possibilities that are discussed in the present chapter include two currently existing systems: (a) through-sight-video (including audio) and (b) Multiple Integrated Laser Engagement System (MILES) integrated with the Precision Range Integrated Maneuver Exercise (PRIME range control and data collection system).[8] In addition, there are two other systems that are under development: (a) Tank Weapon Gunnery Simulation System (TWGSS) and (b) Multiple Integrated Laser Engagement System with Ballistic Trajectory Simulation (MILES II+). When or if either of these become available, they will be important candidates for use in gunnery criterion measurement. Because they would revolutionize the field of gunnery testing and training, full development of these systems seems likely. Therefore, they are discussed as if they are fully developed and operational.

There are strengths and weaknesses to each option, including live fire. It is important to consider the capabilities of the systems from a content validity/fidelity analysis. From an analysis of their performance requirements, some device and equipment applications simply cannot provide data relevant to particular combat gunnery skills. No one component of the test can provide valid scores on all aspects of gunnery. Obtaining performance data from a mix of several options would extend the validity of that information. Careful selection and allocation of methods to performance areas will insure that research questions are answerable. Because the use of the tank is a given, the following sections focus on selection of range facilities and assessment devices. The final section shifts attention from validity issues to reliability and addresses questions related to test length.

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[8]The acronym PRIME has had different meanings. Initially, PRIME was an acronym for Phantom Run Instrumented MILES Enhanced. Since PRIME can be installed at ranges other than the Phantom Run and since TWGSS/PSG may replace MILES as one of the components, the acronym currently stands for Precision Range Integrated Maneuver Exercise.

Range Facilities

Range facilities include training area requirements, kinds of targets, and options for altering target arrays. The following observations are rather obvious, but they are often overlooked in considering test fidelity.

Training Area

Live-fire and instrumented dry-fire testing options are distinct in terms of their training area requirements. Live fire obviously must be conducted on a live-fire range. There are a number of significant constraints related to options for placing targets on the terrain itself. On a live-fire range, targets can be placed only within a narrow alley that typically corresponds to an approximate 60° arc as viewed from a firing tank. Firing locations and driving lanes are constrained so that maneuvering to obtain flank shots on targets is not possible (even if the targets were three dimensional). Moreover within the alleys, targets must be placed to protect the target lifter mechanisms. Thus, pits with berms are constructed for the targets. These berms become relatively permanent cues for acquiring target locations. The terrain of a live-fire range tends to become barren and devoid of vegetation, especially around the target pits. Targets are painted green to represent the camouflage of threat vehicles, but on the live-fire range, the targets have no vegetation with which to visually blend. Instead, they tend to stand out against a background (and foreground) of earth. Thus, live-fire ranges place severe limitations on assessing performance in the target acquisition aspects of gunnery. In contrast, dry-fire exercises can be conducted on local training areas (LTAs) with vegetation (brush, grass, and trees) remaining. Without the need for pits and berms to protect target lifters, options for placing pop-up targets are greater. They can be placed with the vegetation to make target acquisition more realistic.

In addition to target placement restrictions on live-fire ranges, safety restrictions often limit maneuverability. These restrictions prevent the evaluation of certain tactics and procedures. For example, some ranges do not allow off-road movement during live fire. On such ranges, it is inappropriate to score a crew or platoon's use of cover and concealment. Dry-fire exercises, on the other hand, are not as hampered by movement safety constraints. Vehicles can be given more freedom of movement, and crews, platoons, and platoon leaders can be assessed on movement-related tactics and procedures.

Targets

Live-fire targets themselves pose some constraints to performance fidelity. Targets are typically two-dimensional silhouettes of threat vehicles or personnel. Stationary targets pop up using target lifter mechanisms, whereas moving targets move along fixed, therefore predictable paths with some system of rails and/or cables. Compared to the cover, concealment, and movement potential of real vehicles, these panel targets do not represent a significant challenge to either acquisition or tracking skills.

In addition to silhouette targets, dry-fire exercises in an LTA allow the use of actual vehicles, with Visual Modification (VISMOD) kits, to mimic threat targets. VISMOD outfitted vehicles can serve as either stationary or moving targets. While assessment of target identification skills are hampered by the somewhat stilted VISMOD kits, the movement, three-dimensional presentation, and visual signatures (dusk, smoke) are more realistic for target acquisition. In addition, target tracking skills can be more faithfully tested.

Devices and Instruments for Assessing Performance

In addition to targets and ranges, devices and instruments are required for assessing on-tank performance. The options are described below. Several of the instruments are intended to be used in combination with other instruments.

Live Fire

Perhaps the oldest form of assessing gunnery performance is to put ammunition in tanks and see how fast crews can hit targets. Although live fire can be criticized for low fidelity with regard to terrain and targets, there certainly is no question about its fidelity with regard to tank operations *per se*. The traditionally questionable features of gunnery scoring are the extent to which round-to-round dispersion adds random error to the measurement of crew proficiency (Fingerman, 1978) and the reliability of systems to assess whether or not hits occur (Eaton & Whalen, 1980). However, these are reliability problems that are possible to overcome with numbers of repetitions. They do not represent validity problems in scoring. The limits to live fire are cost and fidelity of the range conditions. Validity is affected to the extent that the full domain of tank gunnery cannot be assessed (see above comments on terrain and targets).

Through-Sight Video

Through-sight video (TSV) records the gunnery sight picture and typically the sound from the tank radio and intercom system. In theory, TSV can be used with or without live rounds. TSV can be used to assess gunners' sight pictures at the time of firing as an alternative to counting live-round hits and misses. On the positive side, sight pictures can be used to provide a continuous lay accuracy score rather than a dichotomous hit/miss assessment. Secondly, such lay accuracy scores are not contaminated by the round-to-round dispersion that affects hits. On the other, there are several problems with using sight picture as a surrogate for target hits. In addition to sight picture, achieving target hits also depends on correct switchology skills (e.g., correct ammunition setting, correct lasing, or correct selection of multiple returns from lasing). Because sight picture alone will not provide any information about switchology errors, TSV would seem best suited to assessing only the control manipulation (aiming/tracking) component of gunnery. Even that conclusion must be tempered. Hitting a moving target with an M1 series tank also requires a correct lead solution which results from correct lead dumping and appropriate tracking prior to firing. This second problem is particularly difficult to handle with TSV. Certainly, a sight picture frozen at the time of firing would fail to indicate ambushing the target or rapidly slewing onto a target, two techniques which can achieve a

correct sight picture but are not expected to achieve target hits. Assessing whether or not a lead solution was correct from the videotape alone would be a matter of expert judgement of the sight picture movements prior to firing as well as judgement of the sight picture at the time of firing. On the other hand, TSV can be used to evaluate search techniques, and in platoon engagements, TSV can assist in untangling which targets were visible to whom and who shot whom. The audio portion of the videotape can be used to judge fire commands. In any case, TSV does not provide a very simple solution to measuring gunnery performance. Furthermore, transforming TSV audio and video output into usable quantitative form is very labor intensive. By itself, TSV provides no directly usable information but requires the use of sight picture measurement equipment coupled with expert judgments (Hoffman & Melching, 1982).

Multiple Integrated Laser Engagement System (MILES)

MILES is a tank appended device which operates by pointing a laser beam in the precise direction of the tank gun tube. Laser sensors on the target then detect when a target is hit by the beam. For MILES to provide a hit when the sight picture shows an accurate lay, the tank ballistics computer must be turned off. Otherwise, the automatic ballistic adjustments in gun tube elevation and lead (computed on the basis of wind, cant, range, speed of target, and ammunition) will throw the light beam off the target. Given that the computer is off, the gunner does not need to make any switch manipulations, and there is no requirement for him to lase to obtain range or to track smoothly to set the lead. The only requirement is to have the crosshair on the target at the time of trigger pull. As a result, MILES provides a very low fidelity representation of the marksmanship aspects of gunnery. Aiming and tracking *per se* can be only subjectively evaluated by SMEs evaluating sight pictures from TSV. These sight pictures would be used to confirm whether or not gunners were tracking appropriately to simulate inducing the correct lead solution into the tank's ballistics computer. The extent to which such judgment could be made accurately is unknown.

On the positive side, the safety of MILES does allow use of the system in LTAs where targets can be pop-up silhouettes camouflaged among the vegetation or moving VISMOD vehicles with either type of target dispersed in 360° arrays. Vehicle and platoon movement is unconstrained by the threat of accidentally firing a live round out of the range safety fan or at a fellow tank. The number of targets is not constrained by the amount of ammunition available. Therefore, large target arrays can be represented without draining resources. Thus, the system potentially has more fidelity than live fire for the target acquisition, fire distribution, and maneuver aspects of gunnery. Fire distribution fidelity is reduced however by the inability of tanks to sense each others' rounds.

Precision Range Integrated Maneuver Exercise (PRIME)

PRIME is a computer control system that automates a number of range events for MILES training and provides several enhancements to MILES feedback capabilities. Target control features include automatic target lifting based on location and intervisability of tank to target. Tanks are located on the course by a satellite telemetry link and data is instantaneously transmitted to a central control location. Target kills are evaluated probabilistically

based on assignment of kill probabilities for vehicles the target silhouettes represent. A hit is not necessarily equated to a kill but depends on a "roll of the dice" so to speak. Thus, a tank may have to hit a target more than once for the PRIME system to record a kill and cause that target to fall. In addition, tanks are "killed" by the PRIME system if they remain in the intervisability area of a target and do not kill that target within a programed time period.

PRIME also provides for automated recording of all system events (target up, target down, tank firing, target hit, target killed, and tank killed). Elapsed time for each of these events is also recorded. Thus, PRIME provides a record of who shot whom allowing scoring of platoon fire distribution and isolating "killer tanks" (i.e., those tanks that kill the most targets). At Ft. Hood, PRIME has been coupled with TSV which was time-tagged in synchronization with PRIME recorded times. With TSV, sight pictures and verbal communications become available as an additional source of performance information. Finally, PRIME can be operated with VISMOD equipped vehicles as well as pop-up, stationary and cable-controlled, moving silhouette targets. Further information concerning PRIME is available in Drucker, Campbell, Koger, and Kraemer (1989).

Tank Weapon Gunnery Simulation System (TWGSS)

TWGSS is also currently under development with first article testing scheduled in the near future. Like MILES, TWGSS is a tank appended device using a laser beam to simulate gunnery. Unlike MILES, TWGSS is designed to train all of the gunnery behaviors required for precision gunnery. That is, TWGSS is designed to provide practice on switchology skills as well as tracking and aiming skills. Thus, crews perform with the tank computer on. They must lase and track appropriately allowing the tank computer to make its computations and gun tube corrections. By simulating the ballistics of the tank, the accuracy of all of the gunnery manipulations is rolled up in an outcome evaluation of target hits. In addition, graphic portrayal of obscuration, tracer, and ammunition impact are presented in the gunner's primary sight and gunner's primary sight extension. Like PRIME, a hit is not necessarily classified as a kill, but TWGSS goes further than PRIME in the simulation of weapons effects. Different areas of the target are identifiable, and the effects of target hits are evaluated in relation to target area hit and aspect angle of the projectile. TWGSS also has performance data capture capabilities in terms of time-tagged records of who shot whom and with what degree of accuracy. Some switchology information is also recorded including a match between the ammunition loaded (simulated by the loader pressing a button) and that selected by the gunner and the accuracy of the lase to target. Thus, TWGSS is intended to provide a faithful, high fidelity replication of live fire precision gunnery.

Like MILES, TWGSS is designed for force-on-force exercises. Likewise, it is adaptable to pop-up, stationary targets; cable-controlled, moving targets; and VISMOD vehicle applications that may be more suitable in format to a standardized test of gunnery performance. Thus, TWGSS also has the potential for more fidelity than live fire for the target acquisition, fire distribution, and maneuver aspects of gunnery. But again like MILES, fire distribution fidelity is reduced by the inability of tank crews to sense each others' rounds.

Multiple Integrated Laser Engagement System with Ballistic Trajectory Simulation (MILES II+)

The MILES II+ system requires some "genealogical" explanation. The MILES discussed in a previous section is obviously the predecessor to MILES II and MILES II+. MILES II is an evolutionary improvement to the current MILES. It is currently an unfunded demonstration project by the manufacturer, but plans include its installation at the Combat Maneuver Training Center (CMTC) in Europe. It incorporates a number of data recording and target hit evaluation enhancements over the existing MILES. The ballistic trajectory simulation is a proposed add-on feature for MILES II, hence our acronym MILES II+. Because the ballistic trajectory simulation is the enhancement of primary interest for the current project, MILES II+ is the system we will discuss in this and subsequent sections.

MILES, PRIME, and MILES II+ are all made by the same manufacturer. The systems are all related to one another and designed to be compatible with one another. MILES II+ is like PRIME in its data capture capabilities, although the technologies of the two are different. It does not include automatic pop-up target control but is intended primarily for force-on-force exercises. Again, force-on-force capabilities also imply the use of VISMOD vehicles running standardized paths for standardized testing capabilities. Like TWGSS, target hit effects are evaluated in relation to the area of the target hit. The ballistic trajectory simulation add-on allows MILES II+ to be operated with the tank's computer turned on and requires the gunner to perform all of the steps of precision gunnery. Thus, the ballistic trajectory simulation is a significant improvement over the current MILES in terms of simulating the marksmanship aspects of gunnery. At this time, further development of MILES II+ is tenuous and its exact capabilities are unknown. Therefore, it will not be considered further.

Device Recommendations

Based on the above descriptions of live-fire and on-tank gunnery devices, it is possible to make an initial appraisal of their capabilities for assessing performance on the gunnery subtasks defined in Chapters 1 and 2. The device options were assessed with respect to their capacities to elicit and to record "valid" performance of gunnery speed and accuracy and gunnery procedural subtasks. By "valid" performance, we mean that the device presents sufficient fidelity to require the crew, platoon, or platoon leader to perform all parts of the tasks.

Two ratings were given to each device. The first was an evaluation of their ability to elicit performance of each of the subtasks. In essence, these are ratings of the content validity of the methods. The ratings describe whether or not the methods provide conditions of performance that allow content valid scoring of performance, assuming that engagement exercises or scenarios are written that require the rated subtask. For example, ratings for live fire are not constrained to Table VIII or Table XII tasks. Rather, they include the possibility of loader targets, or other requirements not present in current Table VIII or Table XII, but within the safety constraints of live fire. An "E" is entered in the tables for those facilities or techniques that elicit valid representations of performance. In essence, these are summary ratings of the fidelity of the potential test conditions.

The second rating represented an evaluation of the performance recording capabilities of the devices. These ratings were based on the features of the device to record various aspects of crew and platoon gunnery exercises. Generally these records have to be scored after the event. For example, TWGSS and PRIME are rated in Table 22 as providing platoon level information concerning fire patterns and fire techniques. In actuality, these systems indicate which tank shot which target and at what time. It remains the job of an analyst to study these records and make a determination about whether the pattern of recorded hits conforms to the platoon's intended fire distribution. Thus, an "R" is entered in the tables for those facilities or techniques that provide an information source for evaluating performance. The "R" does not necessarily mean data is produced in a form that can be directly used in statistical analyses.

Live fire implies a live-fire range with stationary, pop-up or cable-controlled, moving silhouette targets. Timing procedures were including in the live-fire ratings. PRIME and TWGSS are rated for use on an LTA with both types of silhouette targets (i.e., stationary and moving) and VISMOD targets. PRIME is rated using MILES. PRIME ratings do not include the capabilities of TSV. TSV is rated separately and only for its recording capabilities. It is useful only with other devices, because it provides no real-time performance cues to crews. The device that TSV is paired with (e.g., PRIME, live fire) determines the response requirements. As rated, TSV includes audio and video recording.

In addition to these devices, presentation of assessment capabilities is not complete without an indication of the role of tank and platoon evaluators or raters. Thus, ratings were also made for the components of crew and platoon gunnery for which rating materials were presented in Chapter 4.

Results

Tables 21 and 22 present the device ratings. Several observations are apparent. As expected from the above discussion, none of the methods combine performance opportunities and measurement capabilities of all tasks. In fact, none of the methods achieve valid presentation of all of the subtasks. The more specific results are organized below in separate sections on crew- and platoon-level domains.

Crew-level gunnery. Crew subtasks focus on the marksmanship (steel-on-target) aspects of gunnery. PRIME and MILES are simply not precision gunnery devices. The switchology and gun manipulation clusters (i.e., lasing, tracking) are sufficiently different for precision gunnery to render them suspect. Live fire and TWGSS are the only two methods that elicit marksmanship with sufficient fidelity for testing. Because of the limitations of the live-fire ranges, live fire was not positively rated for target acquisition. Also, because there is no unobtrusive control for creating tank degradations, live fire was not positively rated for providing conditions for testing ability of crews to diagnoses and select appropriate degraded mode techniques.

Table 21

Device Capabilities for Eliciting and Recording Crew Subtask Performance

Performance Dimension	Live Fire E	Live Fire R	PRIME E	PRIME R	TWGSS E	TWGSS R	TSV[a] R	Rater R
Speed and Accuracy	E	R			E	R		
Subtasks:								
Target Acquisition			E	R	E	R		R
"Switchology" Procedures								
Main Gun	E				E	R		
Degraded - Settings	E				E	R		
TC Position	E				E	R		
Multiple Targets	E				E	R		
Engagement Control Procedures								
Adjust Fire	E		E		E		R	R
Control Movement	E		E		E		R	R
Report	E		E		E		R	R
Smoke			E		E		R	R
Engagement Initiation/ Fire Command	E		E		E		R	R
Manipulation of Gun Controls								
Acquisition - Gunner	E		E		E			
Main Gun	E				E	R	R	
COAX	E				E	R	R	
Degraded - Manipulations	E				E	R	R	
TC Position	E				E	R	R	
Loader Position	E							
Multiple Targets	E				E	R	R	
Degraded Modes								
Selection of Procedures								R
Immediate Action	E							R
Maneuver Tank	E		E		E			R

Note. An "E" in the "E" column indicates that the gunnery method elicits performance of the indicated subtask. An "R" in the "R" column indicates that the device provides support for recording performance on the subtask.

[a]Raters and TSV must be used in conjunction with other methods. Only the recording capabilities are rated.

Table 22

Device Capabilities for Eliciting and Recording "Valid" Platoon and Platoon Leader Subtask Performance

	Measurement Media							
	Live Fire		PRIME		TWGSS		TSV[a]	Rater
Performance Dimension	E	R	E	R	E	R	R	R
Speed and Accuracy	E	R			E	R		
Platoon Subtasks:								
Movement:								
Travel in Formation	E		E		E			R
Bound by Section	E		E		E			R
Overwatch Bounding Platoon	E		E		E			R
Occupy Battle Position	E		E		E			R
Maneuver in Battle Position			E		E			R
Engagement:								
Battle Drills				E		E		R
Employ Fire Patterns	E		E	R	E	R		R
Employ Firing Techniques	E		E	R	E	R		R
Platoon Leader Subtasks:								
Platoon Fire Commands	E		E		E		R	R
Indirect Fire Requests	E		E		E		R	R
Platoon Movement Commands	E		E		E		R	R

Note. An "E" in the "E" column indicates that the gunnery method elicits performance of the indicated subtask. An "R" in the "R" column indicates that the device provides support for recording performance on the subtask.

[a]Raters and TSV must be used in conjunction with other methods. Only the recording capabilities are rated.

TWGSS on the other hand is not limited to live-fire ranges, so there is the potential of providing 360° target placement within vegetated, camouflaged locations. Because TWGSS is designed as a force-on-force trainer, its application to standardized testing of gunnery would be best achieved by use of target vehicles, preferably outfitted with VISMOD kits, moving in scripted but unpredictable patterns. On the other hand, TWGSS is simulated firing that, according to SME anecdotes rather than hard research, creates unnatural conditions and intangible changes in task requirements. Certainly, the loader's main task of loading rounds in the chamber is not replicated by TWGSS.

Live fire *per se* provides no mechanisms for directly recording performance of any of the gunnery subtasks. However, live fire may be coupled with ratings and possibly TSV to achieve scoring of all but the switchology and gun manipulation subtasks. These may be inferred from target hits.

Until TWGSS is available, M1 training research that directly focuses on the marksmanship aspects of precision gunnery is limited to live-fire exercises. TWGSS will improve coverage of target acquisition skills but needs further study to confirm or disconfirm of necessity of firing live rounds for achieving test validity. PRIME could be used for some aspects of crew gunnery such as target acquisition. But even coupled with TSV and evaluator's ratings, assessments of switchology and gun manipulation would be doubtful.

Platoon-level gunnery. The platoon and platoon leader subtasks presented in Table 23 focus on movement and communication aspects of gunnery. For these tasks, PRIME presents engagement opportunities and recording capabilities not available with live fire. PRIME provides target control and allows freedom for target placement and tank movement; therefore PRIME has been rated as capable of eliciting all of the platoon and platoon leader subtasks. Its recording features, however, concentrate on the fire distribution aspects of gunnery. TWGSS, according to latest information, will also provide fire distribution information, and it allows free choreographing of target vehicles. In addition, TWGSS will supply gunnery marksmanship information. In any case, raters are required to fill in the scoring gaps in platoon movement and platoon leader subtasks. Thus, excluding a hit accuracy criterion, either PRIME or TWGSS appears capable of providing conditions for achieving valid test scores. TWGSS can add hit accuracy information as well.

Live fire, depending on specific range conditions and test scenarios, can also support most aspects of platoon level gunnery. The subtask Maneuver in Battle Position is not positively evaluated for live fire because of the limits of maneuver. On the other hand, many of the maneuver subtasks may be rather stilted to conform to safety considerations. PRIME and TWGSS exercises are likely to allow more freedom of movement.

Conclusions

Chapter 1 presented a general scheme for a comprehensive test of gunnery. Eight component parts were specified that test crew and platoon gunnery using live fire and instrumented dry fire with both combat table targets and threat-based targets. Based on this scheme, it is possible to narrow the choices of gunnery devices for use in the dry fire portions of the test. Figure 23 presents the devices recommended for each component of the test. Live Fire Tables VIII and XII are submitted for inclusion in the gunnery test without modification. This segment of the criterion test will anchor the test by (a) providing familiar information that is readily accepted and (b) allowing for the comparison of results with previous research findings. The remaining portions of the test extend data collection to additional types of engagements and to gunnery skills that are not well-suited to live-fire safety constraints.

Test Media	Crew Gunnery		Platoon Gunnery	
	Table Based	Threat Based	Table Based	Threat Based
Live Fire on Live-Fire Range	Table VIII	New Arrays, Additional Ammunition	Table XII	New Arrays, Additional Ammunition
Instrumented Dry Fire on Training Area	Table VIII w/ TWGSS or PRIME	New Arrays w/ TWGSS & VISMODs or PRIME	Table XII w/ TWGSS & VISMODs or PRIME	New Arrays, w/ TWGSS & VISMODs or PRIME

Figure 23. Device assignment for comprehensive tank gunnery criterion measurement. Use of raters recommended for each cell.

There are some trade-offs. TWGSS is the recommended instrumentation for crew- and platoon-level exercises, but TWGSS does not yet exist. PRIME is noted in Figure 23 as an option for the platoon-level exercises. PRIME will not provide adequate marksmanship scores. On the other hand, by using the system of automatic target lifters, PRIME should be less costly and easier to standardize than TWGSS. Target vehicles, along with the personnel, fuel, and maintenance to operate them, are not required. In addition, the PRIME prototype is operational at Ft. Hood, TX.

In summary, when TWGSS is fielded, it should make a valuable contribution to gunnery testing research. Coupled with live-fire testing, the gunnery domain should be well covered with sufficient replication in coverage to allow comparison between the two methods and to increase overall measurement reliability. However, availability is currently an issue and, depending on site distribution, may be an issue in the future. PRIME provides a dry-fire alternative to TWGSS. While not as comprehensive in coverage as TWGSS, PRIME does fill in for the some of the deficiencies of live-fire testing. Specifically, PRIME would allow testing of the target acquisition and platoon subtasks not well-addressed by live fire. Thus, PRIME coupled with live fire can also achieve comprehensive coverage, but they do not replicate each other well so that measurement reliability would come solely from repetitions on each method. Thus, for a given level of reliability, a test using live fire with TWGSS should require fewer live-fire rounds than a test with live fire and PRIME.

Test Length

The previous discussion has focused on content validity issues for gunnery testing. Hoffman's (1989) report on Table VIII live-fire performance also raises a question about test reliability. That report shows very low inter-item correlation suggesting that gunnery performance is unstable, that the Table VIII tasks are very heterogeneous, or both. Fingerman (1978) has also shown that variation in ammunition flight characteristics, known as

round-to-round dispersion, adds error variance to the assessment of crew proficiency. Increasing test length is an effective method for reducing the effects of these sources of error. For experimental studies of alternative training strategies, increasing test reliability is important in so far as it reduces the experimental error term(s) in statistical analysis of the data. That is, in the experimental context, the reliability of the criterion variable is related to the within-cell standard error of the mean, often referred to as experimental error variance. Experimental error variance is composed of variance attributable to individual differences. Individual difference variance, in turn, is composed of true person variance and measurement error variance. Increasing test reliability by adding more observations per person reduces measurement error variance which reduces experimental error variance. Another way of reducing experimental error variance is to add additional persons (or crews, etc.) to the experimental design.

In the case of gunnery research, the cost and distribution of ammunition is of great concern. Increasing the amount of ammunition that any one crew can fire is a burden to the research, either in terms of obtaining funds for additional ammunition or in terms of redistributing the rounds that are available. The alternative of recruiting more crews for the research may be more feasible in that existing ammunition distribution policies do not have to be disturbed. This suggests that the two ways of reducing experimental error, adding observations per person or adding observation of more persons, should seriously be considered in designing research.

Appendix E presents a technical discussion of this comparison. For a given number of crews firing a given number of rounds, the comparison shows that if additional rounds are available, experimental error is reduced more by testing additional persons with those rounds rather than by increasing the rounds fired by the original sample. In fact, Appendix E shows that given Table VIII descriptive statistics, research sample sizes that include four companies (two per experimental group) and a standard length Table VIII will be as powerful as research with half that many subjects and Table VIII lengthened many times over to approach perfect reliability. Thus, the additional live-fire and dry-fire tasks, presented in Figure 23, should be viewed more for their added content validity than for their simple contribution to reliability.

Given this conclusion, Morrison's (1988) presentation of the underlying power formulas and projections of effect sizes that can be detected by comparing samples of different sizes are relevant. His conclusion is that company sized comparisons lack sufficient power to detect group differences using Table VIII as a criterion measure. Thus, sample sizes need to be of battalion and even brigade magnitude.

Chapter 7. Test Scenarios and Control Plans

Previous chapters in this report have addressed scoring and instrumentation for testing gunnery proficiency. Previous reports in this series (Campbell & Campbell, 1990; Campbell & Hoffman, 1990; Doyle, 1990) have outlined the selection of threat target arrays. In order to fully implement these measurement technologies, testing procedures must be specified. The purpose of this chapter is to explain the application of test objectives to a given training facility and to model the scenario development process.

Tank gunnery exercises are typically organized around a specific scenario which presents a hypothetical context for crew and platoon actions. The details for conducting the exercise are spelled out in a set of "control plans" built around that scenario. This chapter outlines the procedure used to develop a scenario and control plans. The development process is based on procedures outlined in Army training doctrine, specifically those set down in FM 25-3, Training In Units (Department of Army, 1984). The process is illustrated by applying it on a specific training facility, Phantom Run Range at Ft. Hood, TX. A scenario and associated controls plan are developed to incorporate threat-based target arrays (Doyle, 1990) and the scoring criterion established in the current effort.

The scenario is developed to support the test objectives. The training facility on which the test is to be conducted requires that the scenario be tailored to fit the terrain and targetry available on that facility. The target arrays are developed from the scenario, based upon the specifications of the range. The operations order (OPORD), overlays, fragmentary orders (FRAGOs), and related messages are drafted to support the scenario and to direct the tested crew or platoon through the exercise. The target operator instructions are keyed to the scenario through the FRAGOs and messages. The evaluation criteria (Appendix B) that support test objectives are selected, and the summative rating sheets are reproduced for the scoring packet. The evaluator worksheets are extracts of the evaluation criteria and facets, tailored for each engagement in the scenario. Figure 24 provides a graphic overview of this process.

The practical application of the test development process assumes two key organizations: a test agency (e.g., ARI, TEXCOM, PM-TRADE) and a subject organization (e.g., a tank battalion). The test agency is defined as the organization conducting the test. The key player in the test agency is the developer or project officer. The developer will normally have a support team including other researchers and administrative personnel. To the extent that research personnel share decision making authority regarding test design, they may be considered agents of the developer. Throughout the remainder of this discussion, the term "developer" will refer to the project officer or any member of the research staff making decisions on his or her behalf. The subject organization is the pool from which subject crews or platoons might be drawn. The subject organization or its parent organization would normally be called upon to provide evaluator support and some degree of administrative and logistical support. Among this organization would normally be a point of contact or project officer that would be the primary source of subject matter expertise.

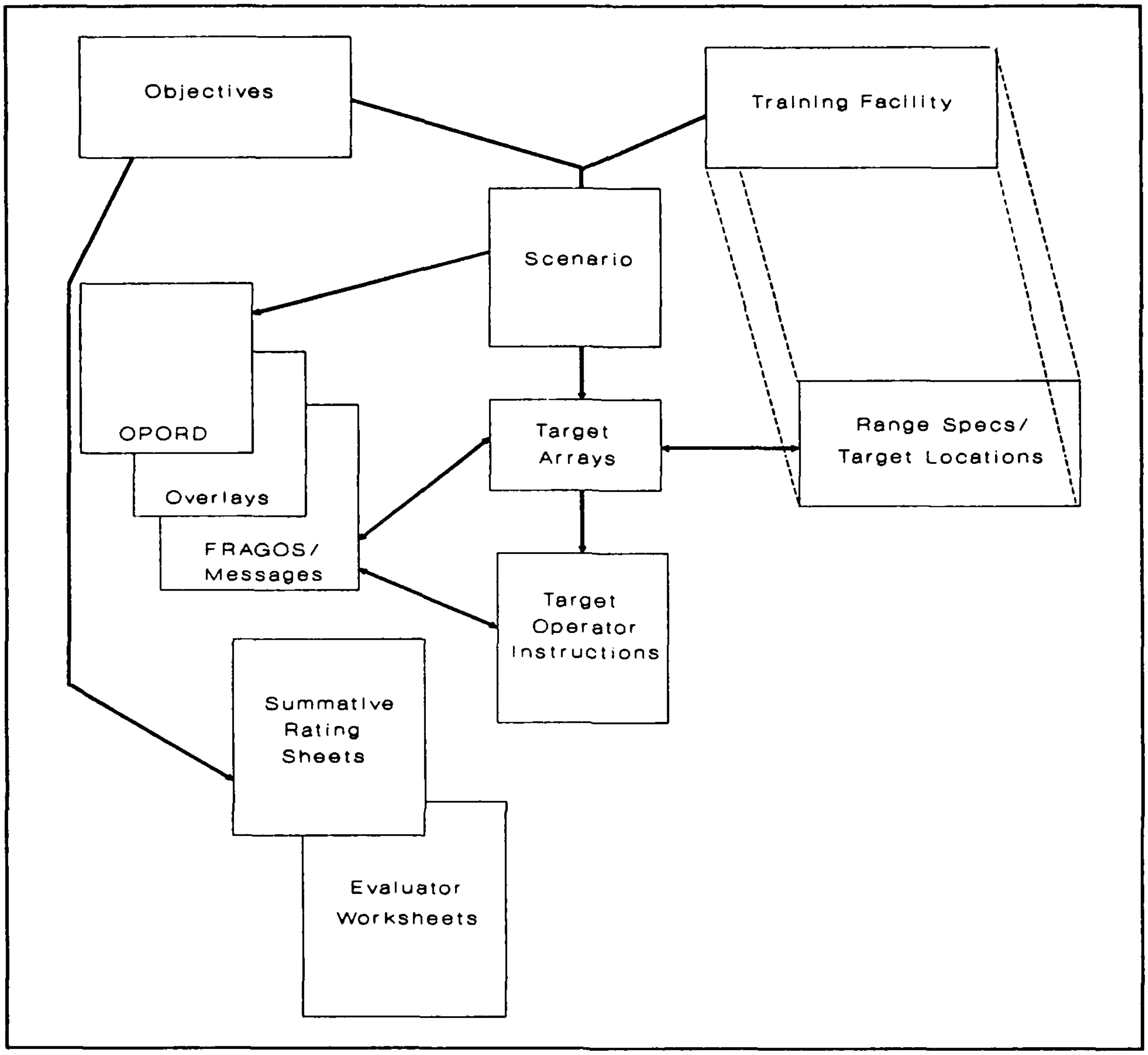

Figure 24. Scenario and control plan development.

The scenario development process relies heavily upon subject matter expertise. The viability of proposed target arrays for the given training facility must be reviewed for tactical suitability and intervisibility. Concept approval of the scenario and sequence of engagements also requires subject matter expertise, as does preparation of the operations order (with enclosures), warning orders, and messages. Finally, a subject matter expert must verify the evaluation criteria and facets appropriate to each engagement. This would normally be a staff officer or non-commissioned officer with significant knowledge and experience from the subject battalion or its parent

organization. Throughout the remainder of this chapter, the term "SME" will be used to refer to this individual, and by extension, to any member of the organization that supports the primary individual or that exercises authority over him. For example, the operations officer of the subject battalion (a major) may be the primary point of contact, but he may cause his assistant (a senior lieutenant or junior captain) to do the majority of the "leg work." The operations officer would probably review the material prior to sanctioning it. Thus, both officers would assume the role of SME.

The following discussion of the development process will include recommendations regarding developer and SME responsibilities. Except as noted, these refer to the generic concept of each as defined above. To illustrate the process of developing test procedures, two of the authors of the present report assumed the roles of the two major participants: the test developer and the subject matter expert. The subject matter expert performed 90-95% of the scenario development while the test developer provided only general design guidance. In practice, the process could accommodate a great deal more participation by the developer, thus reducing SME participation, but even so, it is likely that the SME will be responsible for the bulk of the tactical design effort. If the test developer has sufficient experience with combined arms operations, he may perform both functions. However, in so doing, it would be prudent for the developer to seek other SMEs to review the test plan prior to publication.

Engagement Selection

Engagement selection in a normal training exercise would be based upon the intended objectives of that event. In a test situation, the specific engagements would be directly related to those objectives that are to be measured. These objectives would be specified by the test developer. As indicated in Chapter 6, test objectives may include Tank Table tasks as specified in FM 17-12-1 (Department of Army, 1988) or threat-based target conditions. Our sample scenario focuses on the later.

Campbell and Hoffman (1990) present a means for selecting threat-based scenarios in both training and testing situations. Test development would normally depend upon the specification of mission objectives that did not apply to this example. Therefore, the Campbell and Hoffman procedure was deemed inappropriate and not used. In the sample application, the developer defined the goals as follows: (a) to test the subject platoon across the entire range of tactical situations and (b) to demonstrate the application of the threat-based methodology to a specific training facility. In order to meet these goals, one engagement was selected from each of the six scenario types developed by Doyle (1990). The scenario was developed to incorporate these six engagements in a logical sequence for a particular training facility.

Facility Selection

The concept of a generic exercise at any level is realistic only to the extent that the engagements themselves can be transferred to the subject training facility. Scenario development can go only so far prior to the specification of a facility. While there are various generic facility concepts such as PRIME and the Multi-Purpose Range Complex (MPRC) with

potential Army-wide application, such details as operations orders, control plans, and target arrays have to be tailored to the actual terrain base and unit size. For example, the single-tank gunnery engagements specified in FM 17-12 series manuals are very specific. Armor units Army-wide have reasonable access to ranges that accommodate Tank Tables I-VIII without significant modification. However, the engagements in Table VIII are not tied together in any standard scenario. Any unit that desires to fire Table VIII in a logical sequence and under realistic tactical conditions must develop the scenario themselves. If no scenario is used, the execution of Table VIII gunnery is more analogous to conventional target shooting than to tactical training. The platoon level exercises (Tank Tables XI and XII) imply a tactical scenario, but the specified conditions for each numbered task (offense and defense) clearly indicate that the tasks must be rearranged and tied together to form a tactical scenario. For example, defensive tasks 3 and 5 and offensive tasks 3 and 4 specify that the engagements are to be conducted with illumination at night.

The developer may select or request a certain facility for any number of reasons. It is even feasible that an operational test of a given training range is the purpose of the test. Facility selection may be driven by range availability or the test requirements. For example, if any main gun tank range will do, then the decision would be based upon what ranges are expected to be available during the proposed test period. On the other hand, the test objectives could only be accommodated on one particular local facility. In any event, the SME should be consulted before facility selection is finalized. The SME would normally be able to determine whether the target facility would accommodate the test. In addition to his own experience, the SME would have access to the local range control office to verify facility suitability. He would also be able to suggest alternative facilities. If the facility is the subject of the test, and if a design specification of the range is that it accommodate certain engagements, then any apparent facility/engagement mismatch identified by the SME would provide a significant finding for the test. The SME would then be consulted to describe the limitations of the range and to suggest which engagements are viable alternatives.

The staff involved in the current effort has had recent exposure to the PRIME facility, known as Phantom Run, at Ft. Hood, TX. This particular facility is designed to use sophisticated direct fire simulation, position tracking, and target control methods in support of crew- and platoon-level tactical and gunnery training. Furthermore, Ft. Hood was considered as the site for a test of the scoring methodology presented in previous chapters. Given, therefore, the option of a live main gun range or an instrumented dry-fire facility, the facility selection criteria was reduced to a question of tactical constraints. A live main gun range does not present the 360° target environment possible on a dry-fire range. In that the developer desired replication of the 360° battlefield, the PRIME facility provided a convenient and appropriate example for this application.

Target Arrays

Once the training facility specifications and the objectives were known, the developer suggested a sequence of engagements. Preliminary work accomplished by the developer suggested target arrays for each engagement type. These arrays were developed by comparing the desired engagement type

and expected platoon position with the range layout. Target locations that corresponded with the specified array from Doyle (1990) were identified. Then, the concept was given to the SME to determine whether the tactical situation could accommodate all engagements within available resources.

Among the sample threat arrays selected from Doyle (1990), there were three offensive and three defensive engagements. A well-organized scenario can easily shift the focus between attack and defend, but it is preferable to establish one or the other as the framework for the exercise. Even in the case where there is clearly an offensive and a defensive phase, the initial phase defines the predominating operation. The developer had specified an attack task as the first event in the scenario. It was unclear whether this decision was arbitrary or whether it was reflective of prior exercises the developer had witnessed on Phantom Run. When the SME reviewed the outline scenario, he chose to retain the offensive framework and developed the scenario accordingly.

The sequence of engagements depended upon the availability of targets, intervisibility ranges throughout the training complex, and the ability to tie the scenario together logically. During the development process, the SME considered and rejected several candidate target arrays and engagement sequences because they violated the concepts outlined above or because the resources were not available. For example, one particular engagement called for the platoon to encounter targets behind as well as in front of its current position. The optimum location for that engagement did not fit within the logical flow of the scenario. Therefore, a position and target array had to be developed that fit better within the tactical scenario. Throughout this process, the SME had to consider compromises between a perfect replication of the arrays from Doyle (1990) and that which was feasible within the available resources. As it currently exists, Phantom Run has 52 target pits. The SME assumed that very little, if any flexibility existed regarding adding additional target positions. He did assume that it would be feasible to move a limited number of lifting devices from one position to another, such that two different target silhouettes, oriented at right angles, might be co-located. However, he otherwise rejected the notion that the range could be entirely redesigned. The SME was able to accommodate all the proposed engagement types, but had to revise the proposed sequence, and to revise the arrays for those engagements that were moved.

Control Plans

Control plans include various documents used by the control and evaluation team to structure the test event. They range in nature from general plans, such as the scenario, to very specific plans, such as the target sequence instructions. The primary purpose of the control plan in a test situation is to standardize the conditions of the test for all subjects.

Given the finalized target arrays and engagement sequence, the various control plans provide the detailed instructions for control and evaluation personnel. Control plan and target array development would usually be accomplished concurrently. The overall scenario would guide target array development. The controls required to move the platoon about the facility in order to actuate each engagement would be considered as the array is refined. This is particularly important in that the platoon is mobile while the target

devices are not. Once targets are emplaced, the array becomes inflexible. Therefore, the SME would publish the control plan to ensure that the platoon is moved to the right place for each target engagement and to ensure that each engagement is initiated at the appropriate time. The result of the example scenario development process is in Appendix F. Table 23 summarizes the elements of the control plan.

Scenario. The test developer would provide the general concept, based upon the test objectives. The SME would develop the scenario and write the chronological narrative of the test event. The amount of detail required for the scenario is generally dictated by local policy and experience. For example, a scenario written for a company team live-fire exercise at Fort Benning, GA in 1984 (USAARMC & USAIS, 1985) required a detailed description of where the combat vehicles were to maneuver and where the targets were to be located, accurate to within 50 meters. Furthermore, the scenario narrative had to explain how the force was to be moved (e.g., which element was to move when) and had to outline specific safety procedures to be followed by overwatching sections. Generally speaking, a requirement for greater detail places a greater burden on the SME.

Master Event List. The Master Event List (MEL) is based upon the engagement sequence defined by the developer as modified by the SME. Again, the SME would be responsible for the details of this document. Specifically, the SME would determine what information the platoon needs and when. The SME would arrange that information in a table. The table incorporates brief messages and cross-references to enclosures such as lengthy messages and orders. The messages in the MEL may be written as message texts or as descriptions, providing for some degree of flexibility upon execution. There is an advantage to specifying the text in that all test subjects would receive exactly the same information. On the other hand, the descriptions can be used by, for example, the company commander and adapted to his particular standard operation procedure (SOP) or radio style. As long as the correct information is transmitted, there is a slight advantage to this adaptation in that the platoon leader receives the message from a familiar source and in a style with which he is already familiar.

Enclosures to the MEL would also be written by the SME. The developer might draft an inbriefing that explains the purpose and scope of the test and what is expected of the subject. This would be incorporated by the SME into the overall inbriefing, which would provide general background information about the test scenario. As an alternative, the SME may choose to incorporate the tactical inbriefing into the initial operations order (paragraph 1--Situation).

Target Sequence Instructions. This table provides specific instructions to the target operator. It is derived directly from the target arrays developed earlier. Given that the arrays are already known, this task does not depend upon subject matter expertise. The SME would provide the initiating cues (from the MEL) and array specifications needed to compile the table. The actual work may be accomplished by the developer, the SME, or virtually any member of their support staff. The target list, an optional enclosure to the target sequence instructions provides specifications for the targets to be emplaced. Details of the target list would also be derived from the arrays. This document could also be compiled by virtually any member of the design team.

Table 23

Scenario and Control Documents

Item Component	Nature/Purpose
Scenario	Narrative overview of the exercise. Describes the general flow of events.
Master Events List (MEL)	Tabulated summary of key events and messages. Cross-indexed to the target array.
Inbriefing text Warning Order Operations Order Overlay(s) Execution matrix Fragmentary Orders	Enclosures to the MEL including the text of long messages and any graphics that are to be provided to the platoon's leadership for the exercise.
Target Sequence	Tabulated summary of the target arrays including presentation cues and exposure times. Cross-referenced to the MEL.
Target List	Enclosure to the Target Sequence containing a tabulated list of target positions and types.
Scoring Packet	Evaluation documents.
Hit Scoring Record	Forms for tabulating hit data and computing hit rates.
Summative Rating Scales	Generic rating sheets for platoon and Pldr/PSG evaluation criteria.
Evaluation Criteria/Engagement Matrix	Matrix used to cross reference engagements and evaluation criteria.
Engagement Worksheets	Evaluation worksheets cross-referenced to the scenario and tailored for each engagement.

Scoring Packet. The developer would normally provide the generic portions of this document. The SME would generally be responsible for tailoring the packet to the scenario. The hit scoring procedure is a generic process that may require some specific preparation (e.g., given that engagement N will consist of one set of X tanks and Y BMPs and that each target is to be presented for Z seconds, a point calculation table may be generated for that particular condition/engagement). That process would be accomplished by the development team (developer or his support staff) using the method outlined in Chapter 3 of this report. Note that this step in the process would be dependent upon the SME's approval of the target arrays.

The developer would specify which engagement criteria are necessary to support the test. The SME would verify that those criteria will, in fact, be observed given the scenario, and where during the scenario they might be observed. The SME would cross-reference the engagements with the evaluation criteria (to include each facet) in an evaluation criteria/engagement matrix. Individual worksheets would then be developed for each engagement. The individual worksheets could be generated by the developer's support staff based upon the SME's input. In other words, once the evaluation criteria/engagement matrix is complete, virtually any member of the staff could compile the worksheets.

Summary and Conclusion

Scenario development is an involved process that is essential to the conduct of a meaningful tactical/gunnery test. It begins with the specification of objectives and the selection of a training facility and culminates with the publication of a detailed control plan. The scenario objectives are established by the test developer. The developer depends heavily upon the tactical and technical knowledge provided by SMEs. These personnel tailor the test to the available terrain. SMEs also ensure external validity by verifying the tactical soundness of the test event. Every element of the test plan is cross-referenced to ensure internal consistency. Although this process is extensive and generates a great deal of paperwork, the result is a comprehensive, standardized packet of test control instruments.

A sample scenario and control plans are presented in Appendix F to illustrate the use of threat-based target conditions for platoon gunnery. Completion of the eight-fold test array presented in Chapter 6 requires the execution of similar steps for crew gunnery against threat-based targets and for crew and platoon gunnery using Combat Table specifications. The final appendix in this report, Appendix G, presents the starting point for the Combat Table exercises by presenting Phantom Run target locations that replicate Tank Tables VIII and XII.

Chapter 8. Highlights and Conclusion

For research comparing training alternatives in tank gunnery to be successful, researchers must (a) understand the nature of the criterion they are using as a dependent variable and (b) have appropriate methods and instruments for assessing gunnery proficiency. The purpose of this report is to fulfill both of those needs. To that end, a significant amount of material was covered concerning the measurement of crew and platoon gunnery.

The armor community frequently summarizes the criterion for tank gunnery with the phrase "steel-on-target." Often the reference is phrased something like, "It doesn't take a rocket scientist to know that the faster you put steel-on-target the more likely you are to win." Given that identification of the criterion is the prerogative of the sponsoring organization, the acceptable starting place for criterion development in gunnery research is with the steel-on-target concept. The purpose of this report was to develop that concept into a set of products that researchers may use in measuring tank gunnery. Production proceeded through a number of phases which turned out to be much more complex than the rocket scientist quotation implies.

Highlights of Previous Chapters

In the first chapter, the steel-on-target concept was explored from the viewpoint that neither "steel" nor "target" have singular meanings. That is, there are a wide variety of tank gunnery procedures (precision, degraded, COAX, TC Cal .50, etc.) that represent options for delivering different kinds of "steel." Use of the these different firing options is dependent on a variety of conditions, not the least of which is the array of targets to be destroyed. Thus, Chapter 1 reviewed the crew and platoon tank gunnery domain definitions developed by Morrison et al. (1990). Chapter 1 also addressed the problems inherent in relying on Table VIII scores for training research. As a result of these considerations, a comprehensive gunnery criterion test was recommended. The test comprises three parameters each with two levels of conditions for a total of eight separate components. The parameters are (a) skill echelon (crew/platoon), (b) target base (Combat Tables/threat arrays), and (c) firing mode (live fire/instrumented dry fire). The skills that can be tested within each component vary as a direct function of the three parameters. Figure 25, repeated from Chapter 1, depicts the eight components of the gunnery proficiency test.

Chapter 2 described measurement requirements for assessing crew and platoon gunnery proficiency. In essence, it documented the need for both process and outcome measures. Outcome measures (i.e., speed and accuracy scores) are based on the steel-on-target notion. They provide a summary of gunnery proficiency. Process measures dissect the strengths and weaknesses of the various behaviors and actions required to achieve proficiency. Chapter 2 recommended that process assessment for training research be conducted at a macro rather than a micro level based on the domain definition presented in Chapter 1. Figure 26, modified from Chapter 2, illustrates the components of crew gunnery. Except for the gunnery conditions box, each aspect of gunnery needs to be evaluated.

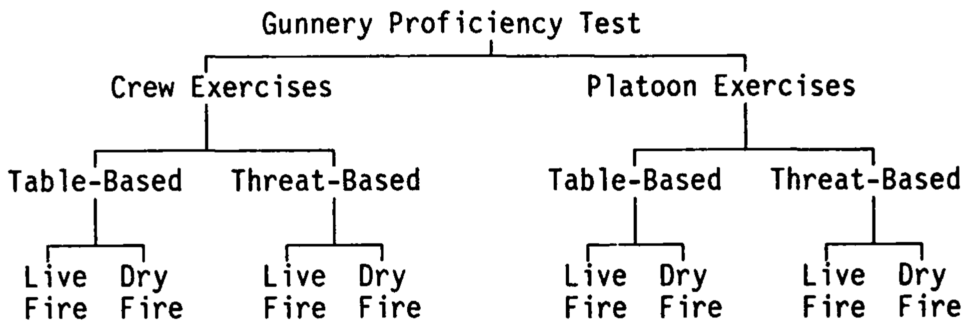

Figure 25. Components of a comprehensive tank gunnery assessment.

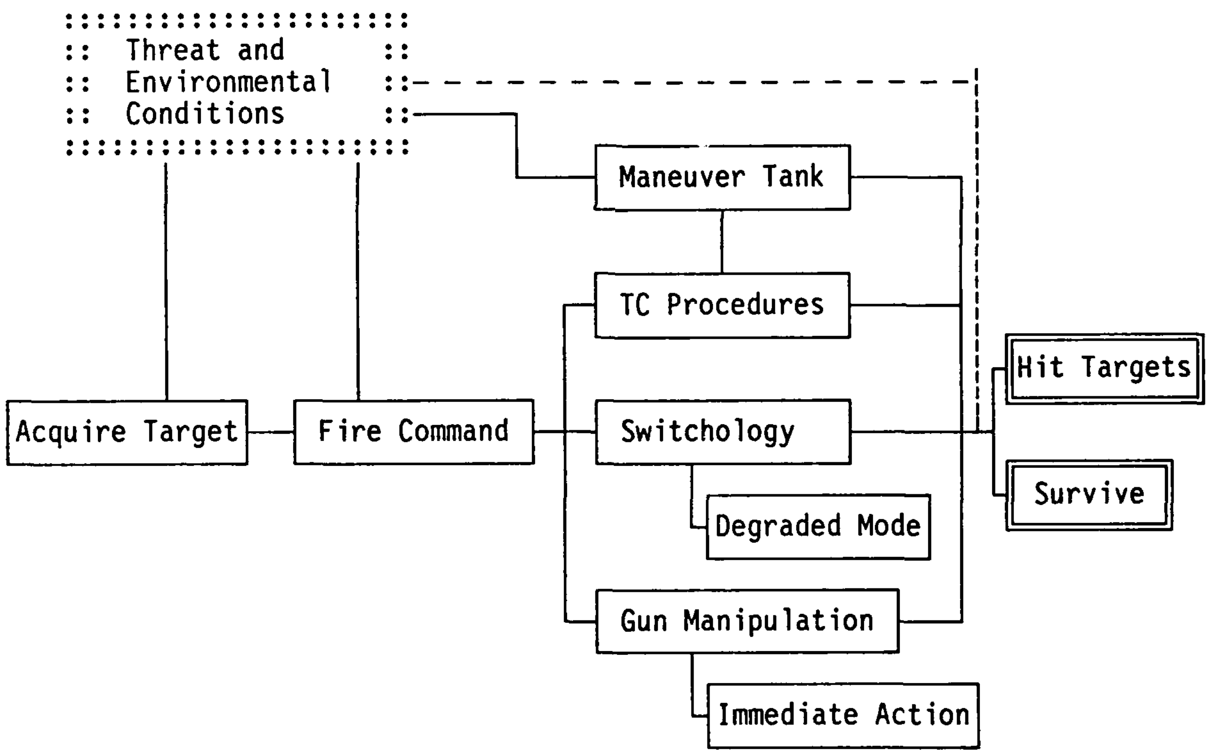

Figure 26. Model of crew gunnery for analyzing performance measurement needs. Solid lines enclose process components; double lines enclose outcome components; and double dotted lines enclose conditions of performance.

Chapter 3 discussed the complexity of quantifying gunnery proficiency using the speed and accuracy of target hits as outcome measures. After reviewing alternatives, the hit expectation ratio metric that underlies the relationship for Table VIII scoring was identified as the most conceptually complete metric available. Hit expectation ratio includes speed and accuracy of hits, and it incorporates the aspect of survival associated with hitting targets in order of their threat magnitude. A spreadsheet format was presented for extending the calculation of hit expectation ratio for crew gunnery with three, four, and five threat targets in an array. Calculation of hit expectation ratios on a larger scale (i.e., friendly tank platoons versus threat company or larger) is complicated by the necessity of modeling targeting decisions (e.g., target selection and sequencing) on the part of the threat weapon systems. The mathematics of a suggested solution for calculating a platoon gunnery hit expectation ratio was presented.

Chapter 3 also discussed the intricacies of setting standards on gunnery outcome measures. Measurement and political issues interact in the standard setting arena particularly in relation to the army's venerated "steel-on-target" criterion. Based on our analysis of the advantages for explicit standards for use in training research, tempered by our perception of the current political climate, we recommended that no immediate action be taken by the research community regarding speed and accuracy standards.

Chapter 4 described instrument development for scoring the process aspects of crew and platoon gunnery. In evaluating existing gunnery scoring requirements, it was found that both crew and platoon process scoring procedures combine outcome scores (i.e., speed and accuracy) and process scores to yield an overall gunnery score. The overall score does not distinguish between outcome and process, thus masking the discrete data required for research. In many circumstances, the existing process measures call for evaluative judgments without establishing clear, observable criteria. Thus, an alternative scoring procedure was developed that identified evaluation criteria for crew, platoon, and platoon leadership processes. Each criterion contains a number of facets that represent discrete, observable behaviors relevant to tactical gunnery performance. These facets allow an evaluator to indicate how often the crew, platoon, or platoon leader performs those actions suitable to the tactical situation. Decisions regarding the suitability of certain actions within the tactical environment are entrusted to trained evaluators. It is hoped that using trained evaluators to rate observable behavior will reduce the impact of arbitrary, subjective judgments. While the facet ratings provide discrete data, a developmental concern was that too much data would be generated and that small sample sizes would limit the usefulness of that data. Therefore, it was suggested that facet ratings be summed to yield a composite rating for each evaluation criteria. This effectively reduces the number of items to be analyzed and strengthens the statistical validity of the research. At the same time, the discrete data are still available at the facet level to investigate aberrant trends within any evaluation criterion.

The introduction of a new scoring procedure presents raters with a variety of potential problems, not the least of which is unfamiliarity with the rating format. Chapter 4, therefore, included a prescription for rater training. In addition to familiarizing raters with the new format, the workshop trains evaluators to avoid common rating errors.

Chapter 5 addressed standard setting issues and provided procedures for setting standards on the gunnery process rating scales presented in Chapter 4. Although we recommended not setting performance standards for the gunnery speed and accuracy outcomes, we reversed our decision with regard to the process measures for three reasons. First, in contrast to hit expectation ratio, the process ratings are new and have no emotional overtones. Therefore little, if any, political risk is involved in setting standards on the rating scales. Second, traditional methods are easily adapted into a simple, straightforward procedure for setting standards on the rating scales. Third, standards for the rating scales add interpretative meaning to the scores produced by using the rating scales. Thus, the summarization of data analyses can be simplified if standards are available to describe qualitative changes in levels of performance.

The standard setting procedure recommended in Chapter 5 establishes four levels of performance: (a) distinguished, (b) superior, (c) qualified, and (d) unqualified. SMEs first identify three cutoff ratings (i.e., distinguished, superior, and qualified) for each facet of each evaluation criterion. Facet ratings within an evaluation criterion are first summed to yield an overall criterion rating, SMEs then sum their three cutoff ratings across facets within evaluation criteria. After considering the leniency or severity of their summed cutoff ratings, SMEs have an opportunity to alter those summed cutoffs by identifying three summary cutoff ratings for each evaluation criterion. Following a group discussion of the rationale for their evaluation criterion standards, SMEs again set standards for each evaluation criterion. (The identification of facet cutoff ratings is not repeated.) The final evaluation criterion standards (distinguished, superior, and qualified) are the average of each performance level across SMEs made after the group discussion.

Chapter 6 contained a content evaluation of live-fire and dry-fire instrumentation systems and presented the devices recommended for each of the eight components of the gunnery test (see Figure 3). Live-fire Tables VIII and XII are submitted for inclusion in the gunnery test without modification. This segment of the criterion test will anchor the test by (a) providing familiar information that is readily accepted and (b) allowing for the comparison of results with previous research findings. The remaining portions of the test extend data collection to additional types of engagements and to gunnery skills that are not well-suited to live fire safety constraints. TWGSS is the preferred dry fire instrument; however, it is not yet available. As an alternative, PRIME can be used to support measurement of the aspects of gunnery that are not well-suited to live fire.

Finally, Chapter 7 presented sample test plans for a test application at the Phantom Run range facility at Ft. Hood, TX. This chapter described the documents and details needed to actually execute a gunnery exercise. The procedures described follow standard army protocol to facilitate communication and logistics with Army support personnel.

Conclusion

"Steel on target" refers to one aspect of gunnery training. It is a results-oriented concept that is relatively straightforward. A gunner must be able to kill an opposing weapons system within the effective range of his own tank's weapons. Furthermore, he must accomplish this function with a high level of efficiency (i.e., by conserving time and minimizing exposure). Marksmanship can be reduced to a series of discrete algorithms where certain conditions demand exact responses. In the modern tank weapon system, the machine simplifies the manual procedure such that the gunner can achieve a target hit with a high degree of reliability at extended ranges. Thus, weapons technology insures a high probability of target destruction given a target hit with the proper ammunition. In this study, we chose an outcome measure to score this critical aspect of gunnery and explained a scoring procedure based upon the size and representative capabilities of the target array.

The tactical concepts related to maneuvering, weapons emplacement, target selection, and system survival are both separate from and inexorably linked to the concept of marksmanship. While these aspects are clearly related to the science of gunnery, they are not so easily reduced to discrete if-then relationships. In these aspects, outcome measures (e.g., where the tank ends up after a movement) are subordinate to process, that is, the means of achieving the outcome (e.g., the path traveled and resulting exposure to enemy observation and fires). Because a variety of effective alternatives may exist for any set of conditions, process measures must be based upon a more heuristic criterion. Tactical principles and imperatives must be upheld, but the situational alternatives must be evaluated within the context of a dynamic tactical environment. As such, we presented a means of evaluating the entire gunnery tactical, or process, domain within a realistic combat environment and demonstrated the processes for developing a specific testing or training scenario.

In conclusion, scoring tools for tank gunnery research have been developed. These tools coupled with the task selection method prepared by Campbell and Hoffman (1989), the threat scenarios prepared by Doyle (1990), and the training strategy recommends prepared by Morrison and Holding (in preparation) provide a powerful set of instruments for conducting training research in tank gunnery.

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Appendix A

Extended 1-ON-N Table VIII Scoring System

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1 SPREADSHEET IMPLEMENTATION[1]

The implementation of the Table VIII 1-on-n methodology has been accomplished using Quattro Pro(tm), operating in a Lotus 123(tm), Version 2.01 emulation mode. The spreadsheet file, 1-ON-5.WK1, can be run on Lotus 123, Version 2.01, or any spreadsheet program capable of using this format.

In addition, the Lotus-version has been compiled into a stand-alone program using Jaguar(tm), a spreadsheet compiler. This compiled version may be used legally on any computer and does not require a spreadsheet program to be installed on that computer.

1.1 Instructions

1.1.1 Starting the Program. To use the Lotus-version, simply import the spreadsheet file 1-ON-5.WK1 into Lotus 123, Version 2.01 or Version 2.2. It is assumed the user is familiar with the Lotus spreadsheet and copies the supplied 1-ON-5.WK1 file to the hard disk directory or working disk of interest.

This implementation is limited to five Red targets. The Lotus-based spreadsheet can be modified in a straightforward manner to accommodate more than five targets, but this is not recommended for several reasons: (a) the control panel will spill into adjacent screens, (b) Lotus graphs will not accommodate more than the five Red targets and one Blue tank (i.e., six curves per graph), and (c) a 1-on-5 fight is already quite a mismatch.

To run the stand-alone Jaguar-compiled version of 1-ON-5, a hard disk is required. Copy the files 1-ON-5.EXE, 1-ON-5.JWK, 1-ON-5.OVL, and 1-ON-5.OVR to the hard disk, and type "1-ON-5" at the DOS prompt to start the program. A Lotus-like screen will appear, even though Lotus is not used by the compiled program. The program will respond to a limited set of Lotus-compatible keystroke commands used to move around the spreadsheet, add or change data in unprotected cells, and view results. However, commands facilitating the addition of new cells or the modification of spreadsheet formulas are not supported.

Because normal exercise of the extended 1-ON-5 Table VIII spreadsheet is the same for either the compiled or Lotus-based implementation, the remaining instructions apply to both tools.

1.1.2 1-ON-N Control Panel. The 1-ON-5 spreadsheet has a "control panel" that occupies cells A1..H20 as shown in Figure A-1. This control panel fills most of one 80x25 character screen. The user inputs the qualifications trial data shown in bold (i.e., the exposure times of the Blue tank to each of the Red targets prior to Red target hit) together with the total exposure time to any surviving ("unhit") Red targets (i.e., the time to the end of the engagement). A number of outputs are indicated, including the probability of Blue being hit (and killed), the final probabilities of kill against each Red

---

[1]The purpose of this appendix is to explain the operation of the spreadsheet. Complete development of the logic and mathematics underlying the spreadsheet is presented in Chapter 3 of the text.

```
    A    B          C          D          E          F          G      H
 1 TABLE VIII  Extended 1-on-N        |Human Resources Research Organization
 2             Methodology (n = 5)    |---------------------------------
 3 EXAMPLE TASK; CRITERION = 1,5,6    |ATTN: Gene Hoffman or Ric Blacksten
 4 Instructions at A100..A141         |      (502)942-3232    (703)549-3611
 5 Data tables at A57..G79            |      Ft. Knox, KY     Alexandria, VA
 6 ---------------------------------- ----------------------------------
 7      Blue Exposure (sec) Until Hit Scored on
 8         Red 1    Red 2    Red 3    Red 4      Red 5  Total  Cor-
 9       (MBT of    (MBT   (BMP of  (BMP of      (BMP   Blue  rected
10      Greatest  appears Greatest Secondary  appears Expo-  Expo-
11       Threat) @ 10 sec)  Threat)  Threat) @ 20 sec)  sure   sure
12            12       20        3       29         38    60     38
13                                                    ERROR?
14     **** NOTE: Hit probabilities are notional. ****
15       Probabilities Red Elements Killed
16          0.67     0.49     0.96     0.42       0.40          Final
17                                                              Score
18   /------<----- E(Blue Hits) =     2.936      /---->           68
19  /-------<----- E(Blue Loss) =     0.604      |
20  \------->-----------> Performance Ratio =  4.863
```

Figure A-1. 1-ON-5 Spreadsheet Control Panel--Example 1.

target, the expected number of Red targets hit (and killed), and the resulting performance ratio.[2]

In the example in Figure A-1, the targets are ordered from left to right by decreasing threat to the Blue tank with Red targets 1,3, and 4 appearing initially, and Red targets 2 and 5 appearing at the indicated intervals. The data shown indicate rapid and accurate Blue fire, with hits at 3, 12, 20, 29, and 38 seconds. Even with this gunslinger performance, there is a 60% probability that Blue will be hit, for an expected Blue Loss of .604. Also, it is expected that Blue, on average, will survive long enough to hit only 2.936 Red targets. The resulting hit expectation ratio (2.936 divided by

---

[2] Performance ratio is the Table VIII hit expectation ratio (expected Blue hits divided by expected Blue losses), but we have chosen to rename it. The phrase "hit expectation ratio" tends to evoke connotations beyond its actual meaning (see the discussion in Chapter 3). In actuality, hit expectation is based on a number of subjective judgement, and its value is highly dependent on various engagement conditions that are beyond the control of the crew being tested. It provides little information, in the absolute sense, about a crew's ability to defeat the threat under any conditions other than the exact conditions of particular engagement for which it is calculated. While the term "hit expectation ratio" sounds theoretically precise, the values it produces are not very generalizable and tend to be over interpreted. Therefore, the more ambiguous phase "performance ratio" is preferred.

.604) is 4.863. This yields a failing qualification score of 68, given that the minimal acceptable hit expectation ratio, corresponding to a score of 70, has been set to 5.0.

The user can input other qualification trial data and immediately read the new results from the control panel. In addition to scoring Table VIII data, the control panel can be useful for training purposes, allowing the instructor to demonstrate the importance of proper target selection and rapid hits. Similarly, "what if" analyses can be used to provide student feedback. For instance, in the example shown in Figure A-1, the instructor could show the effect of proper target order, with the hits on Red 1 and Red 3 at 12 and 3 seconds reversed to the correct targeting sequence. The control panel (Figure A-2) indicates that the probability that Blue will be hit drops to 0.586 and that the expected number of Red kills (hits) will increase to 3.021 Red targets, on average. Thus, the hit expectation ratio climbs to 5.155, which yields a qualification score of 75.

```
    A       B         C         D         E          F        G      H
 1 TABLE VIII  Extended 1-on-N        |Human Resources Research Organization
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 6 ---------------------------------- ------------------------------------
 7      Blue Exposure (sec) Until Hit Scored on
 8         Red 1     Red 2     Red 3     Red 4      Red 5 Total  Cor-
 9       (MBT of    (MBT    (BMP of   (BMP of     (BMP   Blue rected
10      Greatest  appears  Greatest Secondary  appears Expo- Expo-
11       Threat) @ 10 sec)  Threat)  Threat) @ 20 sec)  sure  sure
12             3        20        12        29        38    60    38
13                                                       ERROR?
14     **** NOTE: Hit probabilities are notional. ****
15        Probabilities Red Elements Killed
16          0.96      0.51      0.69      0.44      0.42        Final
17                                                              Score
18   /------<----- E(Blue Hits) =      3.021       /---->        75
19  /-------<----- E(Blue Loss) =      0.586       |
20  \------->-----------> Performance Ratio =    5.155
```

Figure A-2. 1-ON-5 Spreadsheet Control Panel--Example 2.

If a target is not hit, the user enters a hit time of "999" for that target. When 999 is entered, the probability of hitting the target drops to zero. In addition, the user enters a total Blue exposure time. The spreadsheet checks this time for logical consistency with the other data and corrects it to the degree possible. If an error is detected, the spreadsheet displays an error flag beneath the user entry and presents a "corrected" exposure time in cell H12. The user may choose to enter a standard duration for a particular engagement and let the spreadsheet correct the exposure time for crews that hit all targets. The user must avoid entering an exposure time that is less than the longest hit time. In that case, if one or more Red targets remain unhit, it is impossible to determine the correct total exposure time. The spreadsheet simply sets the corrected exposure time to the exposure duration till last actual hit.

It is possible for the spreadsheet to accommodate less than five Red targets. This can be accomplished in two ways without restructuring the spreadsheet. The easiest way is to enter a 0 for the exposure time for that target. The second method is to replace the basic curve of Blue vulnerability to the Red target with a curve of zero vulnerability. (See the discussion of the data base later.) In either case, the spreadsheet will return a "No Target" message.

These last remarks are illustrated in the next example, shown in Figure A-3. Here the second Red target has been removed from consideration by entering a 0 for exposure time. The descripticn of the target has been modified appropriately. Red 1 was hit after 3 seconds of Blue exposure; Red 3 and Red 4 after 12 and 21 seconds of cumulative Blue exposure, respectively; and Red 5 was not hit at all, as indicated by the 999 entry. The Blue tank withdrew to full defilade (or the engagement was terminated) after 40 seconds of exposure. Because Blue hit the main threat quickly and was not faced with a second main battle tank, the resulting hit expectation ratio was a respectable 5.079 even though Blue was somewhat slow to neutralize two BMPs and failed to hit the third at all. The reasonableness of these results will become clearer upon viewing the underlying probability curves discussed below.

The exposure times may *exclude* any time during which the Blue tank returns to full defilade. Thus, the sequence 3, 8, 20, 29, and 38 seconds of *exposure* times to hit might represent *elapsed* times into the engagement of 3, 15, 31, 38, and 49, with the Blue tank returning to full defilade in the stopwatch periods 4 - 11 and 16 - 22 seconds. Figure A-4 illustrates these times. Note that because 8 seconds has been entered for Red 2 which does not appear until 10 seconds into the engagement the spreadsheet indicates that there may be an error in data entry. If the 8 second entry is based on Blue exposure time rather than engagement elapsed time, the error statement may be ignored. On the other hand, if Blue exposure time and elapsed time are the same (the tank did not back down into turret defilade), the error notice does indicate a data entry error. (Blue cannot hit the Red before it appears.) Thus, the "ERROR?" indicator is a statement to the user to evaluate the data.

```
    A      B        C         D         E         F       G      H

 1 TABLE VIII  Extended 1-on-N          |Human Resources Research Organization
 2             Methodology (n = 5)      |-------------------------------------
 3 EXAMPLE TASK; CRITERION = 1,5,6      |ATTN: Gene Hoffman or Ric Blacksten
 4 Instructions at A100..A141           |      (502)942-3232   (703)549-3611
 5 Data tables at A57..G79              |      Ft. Knox, KY    Alexandria, VA
 6 ---------------------------------- ------------------------------------
 7      Blue Exposure (sec) Until Hit Scored on
 8         Red 1    Red 2     Red 3    Red 4     Red 5 Total  Cor-
 9        (MBT of          (BMP of  (BMP of     (BMP  Blue  rected
10       Greatest         Greatest Secondary appears Expo- Expo-
11        Threat)          Threat)  Threat) @ 20 sec)  sure  sure
12              3        0       12       21       999    40    40
13                 No Target
14     **** NOTE: Hit probabilities are notional. ****
15        Probabilities Red Elements Killed
16          0.96     0.00     0.71     0.62     0.00        Final
17                                                           Score
18   /------<----- E(Blue Hits) =      2.285      /---->       72
19  /-------<----- E(Blue Loss) =      0.450      |
20  \------->-----------> Performance Ratio =   5.079
```

Figure A-3. 1-ON-5 Spreadsheet Control Panel--Example 3.

```
     A        B           C           D          E           F        G       H

 1  TABLE VIII  Extended 1-on-N        ¦Human Resources Research Organization
 2              Methodology (n = 5)    ¦-----------------------------------
 3  EXAMPLE TASK; CRITERION = 1,5,6    ¦ATTN: Gene Hoffman or Ric Blacksten
 4  Instructions at A100..A141         ¦      (502)942-3232    (703)549-3611
 5  Data tables at A57..G79            ¦      Ft. Knox, KY     Alexandria, VA
 6  ---------------------------------- -----------------------------------
 7       Blue Exposure (sec) Until Hit Scored on
 8          Red 1     Red 2      Red 3     Red 4      Red 5 Total  Cor-
 9        (MBT of     (MBT     (BMP of  (BMP of      (BMP   Blue  rected
10        Greatest  appears  Greatest Secondary  appears Expo-  Expo-
11         Threat) @ 10 sec)  Threat)   Threat) @ 20 sec)  sure   sure
12               3        8        20        29         38    60     38
13                   ERROR?                                ERROR?
14     **** NOTE: Hit probabilities are notional. ****
15        Probabilities Red Elements Killed
16            0.96      0.79      0.55      0.47      0.45        Final
17                                                                Score
18    /------<----- E(Blue Hits) =       3.224       /---->          94
19   /-------<----- E(Blue Loss) =       0.556       ¦
20   \------->-----------> Performance Ratio =    5.802
```

Figure A-4. 1-ON-5 Spreadsheet Control Panel--Example 4.

1.1.3 Graphical displays. The spreadsheet includes three named graphs: P_B_KILLS_RED, P_B_SRV_RTHREAT, VULNERABILITYDB.[3] Invoke these with the Lotus keystrokes: /gnu (/Graph Name Use). Complete the selection by using the cursor keys to highlight the desired graph and pressing enter to view it. The graph may be printed to a PIC file, if desired, or printed directly to your printer if you have a graphics print screen capability.

The P_B_KILLS_RED graph for the last example is shown in Figure A-5. It actually displays two types of information. For each Red target, the horizontal sequence of target markers is placed at the level of final Blue probability of kill against that target. Thus, Red 2, the non-target, is eliminated with probability 1, at the top of the graph, to indicate that it is not a player in this engagement. Probabilities of Blue hitting Red 1, Red 3, and Red 4 are shown by their numbered lines. Red 5 was not hit by Blue and therefore, based on this performance, has a zero chance of being eliminated. The curve in the graph represents Blue survival probability as a function of time. The horizontal line of markers for a particular Red target terminates its horizontal extent at the intersection with the Blue survivability curve: the time corresponding to this intersection is the time at which the Blue tank hit that target during the qualification trial. This illustrates the

[3]P_B_KILLS_RED stands for probability of Blue kills on Red; P_B_SRV_RTHREAT stands for probability the Blue survives Red threat; and VULNERABILITYDB stands for vulnerability data base.

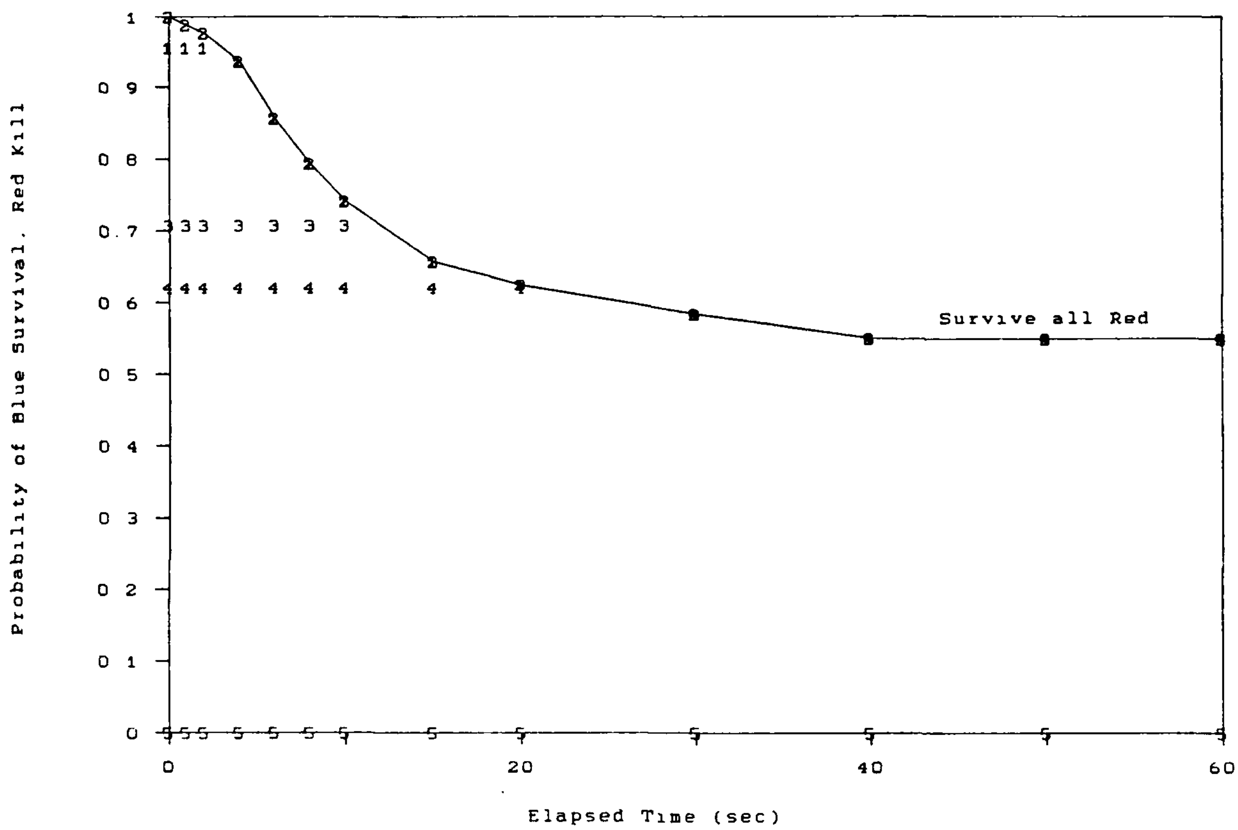


Figure A-5. Probabilities of Blue hitting Red.

essential logic of the methodology: the probability that a particular Red target would actually be hit (and killed) is just the probability that Blue would have actually survived to fire the round that hit the target had the targets been shooting back. Targets that are missed have a zero probability of being hit.[4]

[4]This is a simplified solution to a complex problem. The missed target may have been due to inaccurate gunnery or to round-to-round dispersion. In the former case, the assignment of zero hit probability is clearly acceptable. In the later case, for judging crew proficiency, the zero hit probability represents an unfair penalty. In the absence of switchology evidence and lay error data, it is not possible to determine the cause of the miss. Therefore, the zero rule is invoked for all misses according to the 1984 Table VIII scoring methodology. The issue then becomes one of random error in crew proficiency measurement and the unreliability introduced by round-to-round dispersion.

The P_B_SRV_RTHREAT graph (Figure A-6) shows the Blue's conditional probability of surviving each of the Red targets. Each curve in the graph represents the probability that Blue survived the fires (remained unhit) of a particular Red target at each point in time, given that Blue survived the fires of the other Red targets. Consider the curve for Red 1. It drops steeply for the first three seconds of Blue exposure, at which time it becomes perfectly horizontal. This reflects the fact that Red 1 is hit at three seconds, so will no longer be a threat, assuming Blue survives to deliver that hit. Similarly, the Red 2 curve is flat from the start, because it is hit immediately, the artifice for removing it from consideration. The curves for Red 3 and Red 4 decrease to the time at which they are hit. The curve for Red 5, which was never hit, decreases until the point in exposure time at which Blue withdraws to full defilade, 38 seconds in the example. Only at that point in time does Blue's survival probability cease to drop.

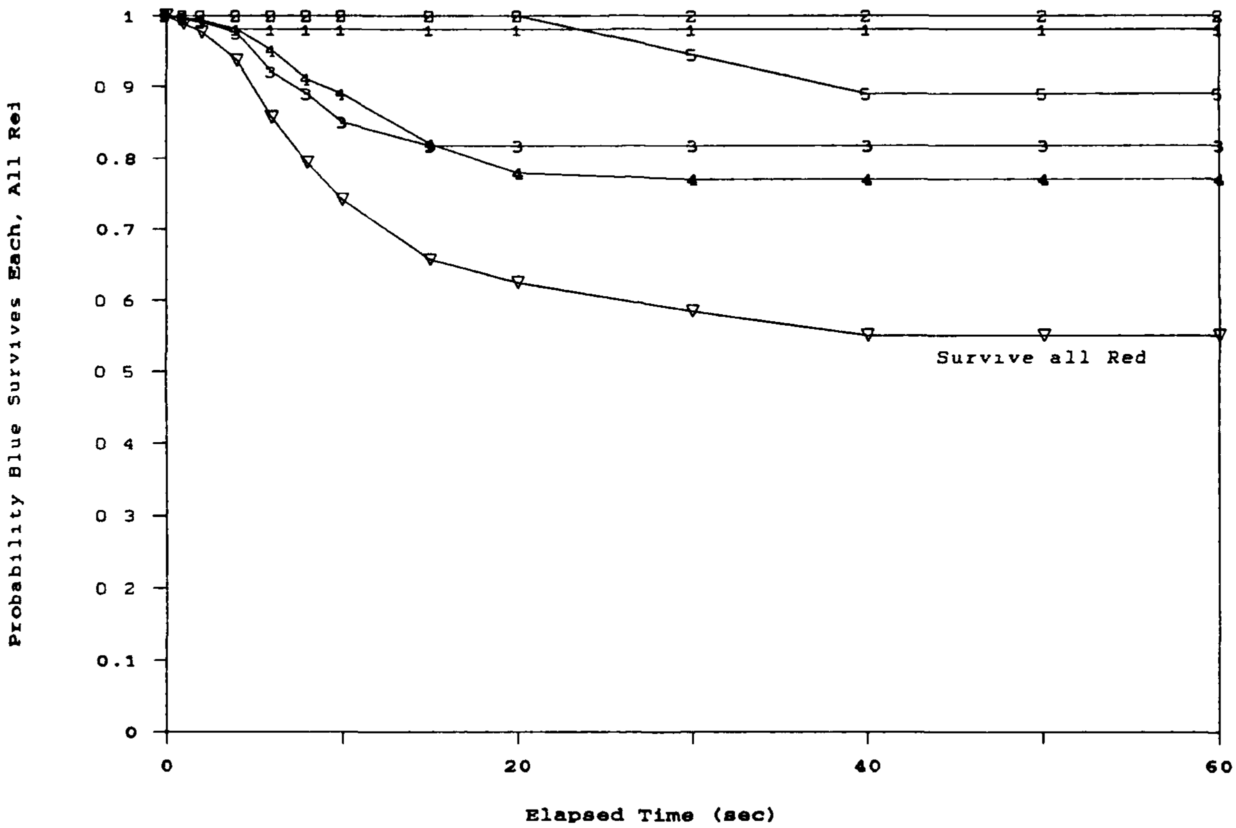


Figure A-6. Probabilities of Blue surviving each and all Red targets.

The underlying data base for all three examples in this appendix is shown in the graph named VULNERABILITYDB (Figure A-7). The curves are strictly notional, but they represent the same type of cumulative probability of hit curves currently used for Table VIII. These data (input in cells A57..G80) would normally be based on threat equipment analyses, considerations of security, and the scenario associated with the qualifications course layout. They are manufactured for our examples to illustrate how the methodology works. For the example, the curve for Red 1 rises the quickest and highest indicating that Red 1 does indeed pose the most serious threat to Blue. Red 2 has the same curve as Red 1, but it is shifted to the right to indicate that it does not appear until 10 seconds into the engagement. Red elements 3 and 4 also appear at the start of the engagement along with Red 1, but they represent lesser threats than Red 1. Red 5 is the least threatening and does not appear until 20 seconds into the engagement.

1.1.4 Changing the data base. The three part data base, depicted graphically in Figure A-7, is input in tabular form in cells A57..G80 (see Figure A-8). First, the user selects the times associated with the Red cumulative hit probability curves and then enters or revises the data for these curves. Because the program uses linear interpolation in its calculations, rather than nearest point calculations, the 13 time points should be sufficient, particularly if the initial points are close together. Time values are entered in column A, lines 62 through 74. Cumulative hit probabilities for each Red are entered in columns B through F, lines 62 through 74. In addition to the data for the curves, appearance time for the targets is required. This data is entered for each target on line 78. In order to convert performance ratio data into a score, conversion values must be added to the data base. This data, located at G58, G59, and G60 gives the performance ratio corresponding to a qualification score of 0 (ZEROPOINTS), 70 (CRITERION), and 100 (MAXPOINTS), where zero in the minimum score, 70 is the passing score, and 100 is the maximum score. Any performance ratio below the ZEROPOINTS value is assigned zero points, and any performance ratio above the MAXPOINTS value is assigned 100 points. The scoring for performance ratios between ZEROPOINTS and CRITERION and between CRITERION and MAXPOINTS are determined proportionately. Again, this procedure corresponds to the current Table VIII scoring methodology. Figure A-9 illustrates the function constructed by the spreadsheet to convert performance ratios to points for the example where a performance ratio of 1 is ZEROPOINTS, 5 is CRITERION, and 6 is MAXPOINTS. These values are for illustration only: they *do not* imply any endorsement for particular performance standards.

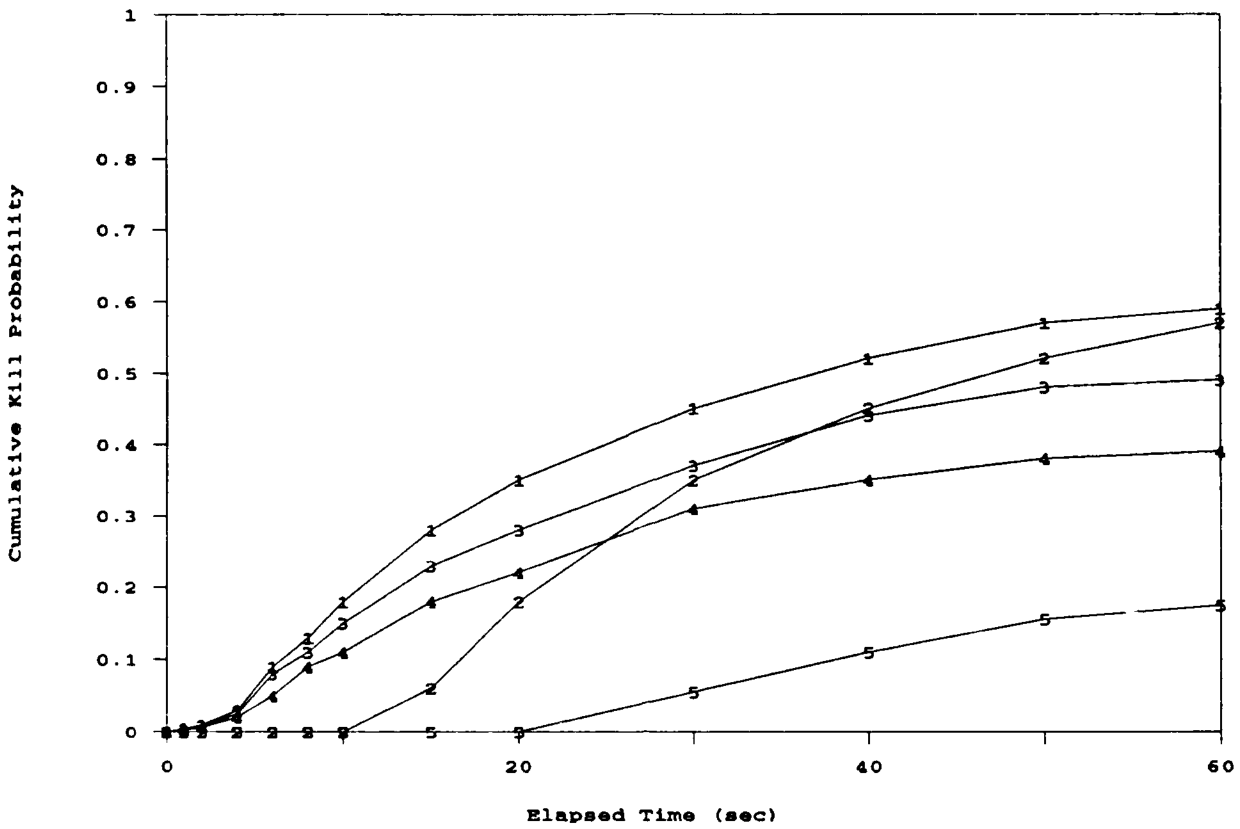


Figure A-7. Blue Vulnerability Data Base.

	A	B	C	D	E	F	G	H	I
57	Stored Input Data:								
58			Hit Expectation Ratio for Zero Points:				1.0 = ZEROPOINTS		
59			Hit Expectation Ratio for 70 Points:				5.0 = CRITERION		
60			Hit Expectation Ratio for 100 Points:				6.0 = MAXPOINTS		
61		Uncountered Probabilities of Hit on Blue by							
62	Time	Red 1	Red 2	Red 3	Red 4	Red 5			
63	0	0	0	0	0	0			
64	1	0.005	0	0.004	0.003	0			
65	2	0.01	0	0.008	0.006	0			
66	4	0.03	0	0.025	0.02	0			
67	6	0.09	0	0.08	0.05	0			
68	8	0.13	0	0.11	0.09	0			
69	10	0.18	0	0.15	0.11	0			
70	15	0.28	0.06	0.23	0.18	0			
71	20	0.35	0.18	0.28	0.22	0			
72	30	0.45	0.35	0.37	0.31	0.055			
73	40	0.52	0.45	0.44	0.35	0.11			
74	50	0.57	0.52	0.48	0.38	0.155			
75	60	0.59	0.57	0.49	0.39	0.175			
76	Red								
77	Appears								
78	At								
79	Time	0	10	0	0	20			
80					End of Data Base				

Figure A-8. 1-ON-5 Data Base.

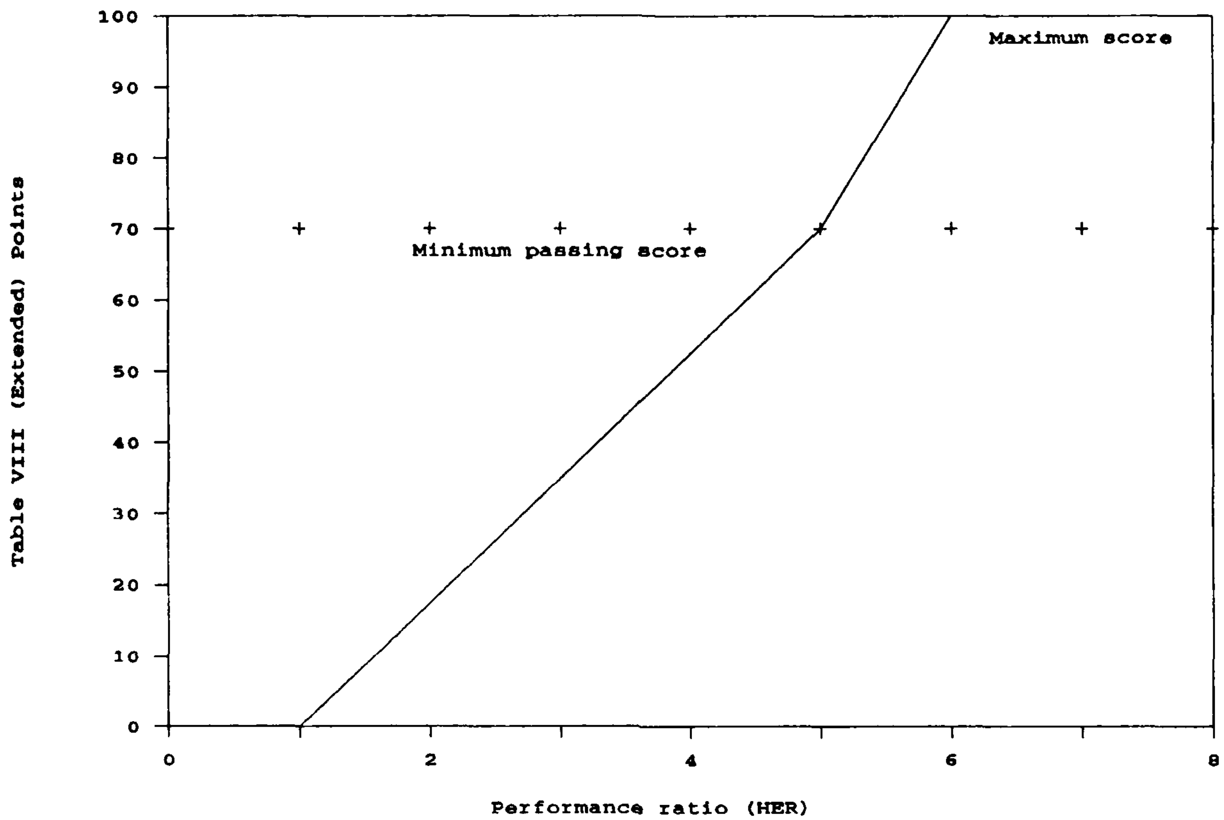


Figure A-9. Example translation of Table VIII hit expectation ratio into Table VIII points.

1.2 Algorithm Design for Spreadsheet Computation

The computations are carried out in essentially the reverse order of presentation of the graphs and control panel. The uncountered Red versus Blue kill curves (Figure A-7) constituting the principal data base are used in conjunction with the exposure times to target hit to compute the conditional Blue survival probability curves shown in Figure A-6: These curves are used, in turn, to compute the combined Blue survival curve, also shown in Figure A-6. The combined Blue survival probability curve is then used in conjunction with the hit times to determine the Red kill (hit) probabilities shown in Figure A-5. These kill (hit) probabilities are used to determine the expected number of hits on Red. The probability of Blue kill, which equals the expected number of hits on Blue, is determined during the above procedures by terminating the Blue survival probability decline at the (corrected) total Blue exposure time. Expected Blue hits and expected Blue losses are used to determine the performance ratio, which is in turn used to determine the final score for the qualifications trial.

The computations are conducted in tabular form with rows corresponding to the times used in the data base. Linear interpolation is used to determine the Blue conditional survival probabilities at exposure time of hit. The actual formulas used may be found by examining the cells of the 1-ON-5.WK1 spreadsheet.

Appendix B

Behavioral Description Rating Scales

CONTENTS

Crew

SEARCH PROCEDURE

The crew searches in assigned sectors between engagements. Search activities are concentrated in the tank's primary sector but also include 360° coverage commensurate with the tactical situation. Each crewman scans his entire sector and performs detailed searches of possible danger areas. Binoculars and night vision goggles are used to supplement the search during open-hatch operations. Vision blocks or night vision periscopes are used during closed hatch operations. Selected crew members continue searching during engagements as the situation permits. Standard sectors for each crew member are:

TC: Left limit of the tank's primary sector to the tank's direct rear (i.e., 11 o'clock to 6 o'clock, with 12 o'clock being to the direct front of the tank, or center of the primary sector).

GUNNER: Left limit to right limit of the tank's primary sector (i.e., 11 o'clock to 1 o'clock).

LOADER: Tank's direct rear to right limit of the tank's primary sector (i.e., 6 o'clock to 1 o'clock).

DRIVER: Left front fender to right front fender of the tank when the view is not masked by terrain.

Individual sectors may be situationally adjusted, particularly according to the mutual support provided by other tanks within the section/platoon. However, the basic principles of all-round security, concentration on the primary sector, and equitable division of labor will not be compromised.

Rating Scales

	Never	Rarely	Often	Usually	Always	Not Observed
Crew members search between and during engagements as crew duties permit.	1	2	3	4	5	NO
Crew members concentrate searches in the tank's primary sector.	1	2	3	4	5	NO
The crew provides 360° security according to the tactical situation.	1	2	3	4	5	NO
Crewmen scan their entire sectors and perform detailed searches of danger areas.	1	2	3	4	5	NO
Crewmen use binoculars or night vision goggles - open hatch and vision blocks or night vision periscopes - closed hatch.	1	2	3	4	5	NO

Crew

ACQUISITION REPORTS

Crew members use acquisition reports to alert the TC and gunner to the presence of a threat, the nature of that threat, and its specific location. Reports are timely, brief, comprehensive, and as accurate as practical under the situation. Target signatures are reported if targets cannot be positively identified.

Rating Scales

	Never	Rarely	Often	Usually	Always	Not Observed
Crew members transmit timely reports.	1	2	3	4	5	NO
Crew members transmit brief reports.	1	2	3	4	5	NO
Crew members give accurate target descriptions.	1	2	3	4	5	NO
Crew members give accurate target locations.	1	2	3	4	5	NO

Crew

NORMAL MODE FIRE COMMANDS AND REENGAGEMENT

Normal mode fire commands are used when the tank is fully operational. Normal fire commands are timely, brief, comprehensive and accurate. The correct ammunition is selected to engage each target according to the tactical situation. Targets are engaged in order of relative threat and according to existing section/platoon fire patterns and techniques. Corrections are used when required. Abbreviated fire commands are used when appropriate. Crew duties (e.g., announcing "UP" and "IDENTIFIED") are performed as required. Targets are reengaged if the first round misses.

Rating Scales

	Never	Rarely	Often	Usually	Always	Not Observed
The TC gives timely fire commands.	1	2	3	4	5	NO
The TC gives brief, comprehensive fire commands (including abbreviated fire commands, if used).	1	2	3	4	5	NO
The TC selects ammunition appropriate to the target and tactical situation.	1	2	3	4	5	NO
The TC selects and sequences targets (multiple target engagements) per target classifications and section/ platoon fire patterns/ techniques.	1	2	3	4	5	NO
The TC gives accurate fire commands (target descriptions).	1	2	3	4	5	NO
The TC gives proper corrections in fire commands (as required).	1	2	3	4	5	NO
Crew members give timely, correct verbal responses (i.e., crew duties).	1	2	3	4	5	NO
The crew reengages targets after first round misses.	1	2	3	4	5	NO

Crew

DEGRADED MODE AND SUBSEQUENT FIRE COMMANDS

The TC modifies the fire command according to known or suspected fire control degradations. Fire commands are timely, brief, comprehensive, and accurate. The TC selects ammunition appropriate to the target and tactical situation. The crew engages targets according to target classification and existing section/platoon fire patterns and techniques. The TC issues the direction element of the fire command when required. The TC estimates the range or asks an adjacent tank for range information when needed and takes appropriate action (e.g., specifies battlesight or indexes the range). The TC announces corrections when required. Crew duties are performed as required. The gunner/TC uses standard adjustments or subsequent fire commands based on crew/adjacent tank observations (sensings) when first round misses occur. If a degraded condition is discovered during an engagement, the crew takes appropriate immediate action to resolve the engagement then isolates and compensates for the fault at the earliest opportunity.

Crew

DEGRADED MODE AND SUBSEQUENT FIRE COMMANDS

Rating Scales

	Never	Rarely	Often	Usually	Always	Not Observed
The TC gives timely fire commands.	1	2	3	4	5	NO
The TC gives brief, comprehensive fire commands appropriate to degraded mode conditions.	1	2	3	4	5	NO
The TC selects ammunition appropriate to the target and tactical situation.	1	2	3	4	5	NO
The TC specifies battlesight when appropriate.	1	2	3	4	5	NO
The TC selects and sequences targets per target classifications and section/platoon fire patterns/techniques.	1	2	3	4	5	NO
The TC gives brief, effective direction elements when required.	1	2	3	4	5	NO
The TC gives accurate fire commands (target description, direction, range).	1	2	3	4	5	NO
The TC gives proper corrections in fire commands as required.	1	2	3	4	5	NO
Crew members give timely, correct verbal responses (i.e., crew duties).	1	2	3	4	5	NO
The TC/gunner uses standard adjustments/subsequent fire commands per crew/adjacent tank observations.	1	2	3	4	5	NO
The crew isolates, corrects, compensates for degraded conditions ASAP.	1	2	3	4	5	NO

Crew

MOVEMENT

The crew moves along available covered and concealed routes* and takes advantage of the tank's speed and available obscurants (e.g., weather, smoke) when crossing danger areas. The crew maintains formation (pace and interval) with the platoon/section. The TC selects primary, alternate, and supplemental positions appropriate to the tactical situation. The crew properly occupies and moves between hide, turret down, and hull down positions per the tactical situation. The TC controls movement into hull down positions to prevent premature exposure in coordination with his section leader or wingman per the section/platoon firing technique. The TC directs movement out of the firing position to avoid effective anti-tank fires and to minimize exposure between engagements. The driver maintains a steady firing platform (smooth acceleration, braking, turning) during engagements. The crew avoids untrafficable terrain.

* The evaluation criteria may be modified to the extent that movement is limited to established routes and firing positions on some training facilities.

Crew

MOVEMENT

Rating Scales

	Never	Rarely	Often	Usually	Always	Not Observed
The crew uses available covered and concealed routes or moves under the cover of smoke/weather.	1	2	3	4	5	NO
The crew coordinates its movement with other tanks in the platoon/section.	1	2	3	4	5	NO
The TC selects primary, alternate, and supplemental positions appropriate to the tactical situation (defense or overwatch).	1	2	3	4	5	NO
The crew properly occupies and moves between hide, turret down, and hull down positions per the tactical situation.	1	2	3	4	5	NO
The TC directs movement out of firing positions to avoid effective anti-tank fires.	1	2	3	4	5	NO
The driver maintains a steady firing platform and a speed appropriate to the tactical situation.	1	2	3	4	5	NO
The crew avoids untrafficable terrain.	1	2	3	4	5	NO

Crew

REACTION DRILLS

The crew reacts immediately to contact during movement. The crew returns fire, reports*, and continues to move:

- If the tank is engaged by an ATGM, the crew turns the tank and turret toward the direction of the primary threat. The driver performs random evasive maneuvers while moving to the nearest covered concealed position. The gunner engages the enemy vehicle/position with suppressive fires. When appropriate, the TC employs smoke grenades or directs the driver to make smoke.

- If a platoon/section action drill is specified, the driver immediately turns the tank in the direction specified and comes on line with the other tank(s) in the formation. The turret is rotated to the direction of the primary threat.

- If a platoon/section contact drill is specified, the turret is traversed to the specified direction while the driver continues to move the tank in the original direction.

* Contact reports are evaluated in a separate evaluation criteria.

Rating Scales

	Never	Rarely	Often	Usually	Always	Not Observed
The crew reacts immediately to contact or drill commands.	1	2	3	4	5	NO
The crew returns fire on contact.	1	2	3	4	5	NO
The crew turns the tank/turret in the appropriate direction per the specified drill or the tactical situation.	1	2	3	4	5	NO
The crew effectively avoids anti-tank fires by evasive maneuver and/or the use of smoke.	1	2	3	4	5	NO

Crew

CONTACT REPORTS

Contact reports are timely, clear, and concise. Contact reports contain an accurate cardinal direction. The crew accurately reports the type of target.

Rating Scales

	Never	Rarely	Often	Usually	Always	Not Observed
The crew immediately reports contact.	1	2	3	4	5	NO
The crew accurately reports direction of the contact to the nearest cardinal direction.	1	2	3	4	5	NO
The crew accurately reports target types.	1	2	3	4	5	NO
The crew transmits brief, clear contact reports.	1	2	3	4	5	NO

Crew

SPOT REPORTS

Spot reports are accurate and comprehensive. Spot reports are clear and concise. Spot reports are transmitted as soon as practical (with emphasis on accuracy rather than timeliness).

Rating Scales

	Never	Rarely	Often	Usually	Always	Not Observed
The crew accurately reports threat vehicle type, number, and actions without error; and time of observation/ engagement within 2 minutes.	1	2	3	4	5	NO
The crew reports threat locations accurately within 200 meters.	1	2	3	4	5	NO
The crew reports friendly actions accurately (number of targets destroyed within +/- 10%).	1	2	3	4	5	NO
The crew transmits SPOT reports as soon as practical given the tactical situation.	1	2	3	4	5	NO

Platoon

ROUTE SELECTION*

The platoon uses routes of movement appropriate to the tactical situation. The routes used provide adequate cover and concealment for the platoon, or if adequate cover and concealment is not available, the platoon uses the route that provides the best available cover and concealment. Available weather (e.g., fog, heavy rain, snow) or smoke is used to supplement natural cover and concealment. The platoon avoids untrafficable terrain.

* Application of this evaluation criteria is dependent upon the amount of freedom afforded the platoon in the exercise. If the exercise conditions strictly restrict freedom of maneuver, applicable items within this criterion are not evaluated.

Rating Scales

	Never	Rarely	Often	Usually	Always	Not Observed
The platoon uses a route of movement appropriate to the tactical situation.	1	2	3	4	5	NO
The platoon uses a route with adequate (or the best available) cover and concealment.	1	2	3	4	5	NO
The platoon uses reduced visibility when available to supplement natural cover and concealment.	1	2	3	4	5	NO
The platoon avoids untrafficable terrain to the extent possible.	1	2	3	4	5	NO

Platoon

MOVEMENT

Platoon movement techniques and formations are suitable to the tactical situation. The relative positions of and intervals between vehicles resemble the formation templates, adjusted according to the terrain being traversed. Rates of movement are appropriate to the tactical situation and allow all tanks in the platoon to maintain formation. When performing bounding overwatch internally or within a larger unit, the bounding element avoids outdistancing the effectiveness of the overwatching element. The platoon quickly changes direction and formation when required by the tactical situation.

Rating Scales

	Never	Rarely	Often	Usually	Always	Not Observed
The platoon uses movement techniques and formations suitable to the tactical situation.	1	2	3	4	5	NO
Tanks maintain formation (individual tanks' rates of movement, positions within formation are relatively constant).	1	2	3	4	5	NO
The platoon adjusts the formation per the terrain being traversed.	1	2	3	4	5	NO
The platoon moves at a rate appropriate to the tactical situation.	1	2	3	4	5	NO
Bounding elements remain within effective overwatch range.	1	2	3	4	5	NO
The platoon changes direction and formation quickly when required.	1	2	3	4	5	NO

Platoon

POSITION SELECTION*

The platoon selects positions (battle positions or overwatch positions) that are suitable to the tactical situation. The positions provide adequate observation and fields of fire, cover and concealment, and room for independent maneuver within the platoon. Individual tank crews select (or the Pldr/PSG designates) adequate primary, alternate, and supplementary positions.

* Application of this evaluation criteria is dependent upon the amount of freedom afforded the platoon in the exercise. If the exercise conditions strictly restrict the positions available to the platoon, applicable items within this criteria are not evaluated.

Rating Scales

	Never	Rarely	Often	Usually	Always	Not Observed
The platoon occupies battle/ overwatch positions suitable to the tactical situation.	1	2	3	4	5	NO
The platoon has adequate observation and fields of fire from selected positions.	1	2	3	4	5	NO
Tanks within the platoon select appropriate primary, alternate, and supplementary positions.	1	2	3	4	5	NO
The platoon selects positions with adequate cover and concealment (covered/ concealed hide positions and routes between firing positions).	1	2	3	4	5	NO
Tanks can maneuver independently within the position without interfering with each other.	1	2	3	4	5	NO

Platoon

INTRA-POSITION MOVEMENT

Tanks within the platoon properly occupy hide, turret down, or hull down positions according to the tactical situation. When not in contact, the platoon adheres to movement restrictions imposed by superior headquarters. Time and movement restrictions permitting, the platoon rehearses movement within and between defensive positions. When in contact, tanks remain in firing positions as long as possible but move to avoid decisive engagement. Tanks move quickly between fighting positions using the best available cover and concealment. Tanks coordinate their movement and fires.

Rating Scales

	Never	Rarely	Often	Usually	Always	Not Observed
Tanks properly occupy hide, turret down, or hull down positions per tactical situation.	1	2	3	4	5	NO
Tanks coordinate their movement and fires.	1	2	3	4	5	NO
Tanks stay in firing positions as long as possible.	1	2	3	4	5	NO
Tanks move to avoid decisive engagement.	1	2	3	4	5	NO
Tanks move quickly between fighting positions along covered and concealed routes.	1	2	3	4	5	NO
The platoon rehearses movement within and between positions (time/movement restrictions permitting).	1	2	3	4	5	NO
The platoon adheres to movement restrictions from higher (out of contact).	1	2	3	4	5	NO

Platoon

ORIENTATION (DEFENSE)

The platoon concentrates search activities on the platoon's primary sector or in the primary direction of the threat. Tank primary weapons systems are oriented within the tanks' primary sectors. Tanks provide mutual support within the platoon. All-round security is accomplished by mounted and dismounted observers and through mutual support with adjacent platoons. The platoon complies with the Readiness Condition (REDCON) specified by superior headquarters. On contact, the platoon reports and masses fires per the standing engagement criteria.

Rating Scales

	Never	Rarely	Often	Usually	Always	Not Observed
Crews concentrate search efforts in the platoon's primary sector.	1	2	3	4	5	NO
Tanks provide mutual support within the platoon.	1	2	3	4	5	NO
The platoon maintains all-round security.	1	2	3	4	5	NO
The platoon complies with REDCON specified by higher.	1	2	3	4	5	NO
On contact the platoon reports and masses fires per engagement criteria.	1	2	3	4	5	NO

Platoon

ORIENTATION (OFFENSE)

When moving, tanks orient on the primary threat or according to the section/platoon formation. When in overwatch, tanks continuously orient on likely enemy positions that may threaten the bounding element and shift from one likely enemy position to the next in coordination with the bounding element's movement. Tanks provide mutual support within the platoon and with adjacent elements. On contact, tanks return fire, deploy, and report.

Rating Scales

	Never	Rarely	Often	Usually	Always	Not Observed
Tanks orient on the primary threat.	1	2	3	4	5	NO
Tanks maintain orientations appropriate to the section/platoon formation.	1	2	3	4	5	NO
Tanks provide mutual support within the platoon and with adjacent elements.	1	2	3	4	5	NO
In overwatch:						
Tanks continuously overwatch.	1	2	3	4	5	NO
Tanks adjust orientation per the bounding element's progress.	1	2	3	4	5	NO
On contact:						
Tanks immediately return fire.	1	2	3	4	5	NO
Tanks immediately report contact.	1	2	3	4	5	NO
The platoon rapidly performs drills per tactical situation.	1	2	3	4	5	NO

Platoon

DIRECT FIRES

The platoon's fires are distributed over the length and depth of the target array per superior headquarters' fire distribution order. Targets within the platoon's area of responsibility are engaged in order of relative danger and from near to far within each danger classification. The platoon fire pattern and volume of fires is appropriate to the tactical situation. The platoon shifts or ceases its fires when appropriate.

Rating Scales

	Never	Rarely	Often	Usually	Always	Not Observed
The platoon properly distributes its fires.	1	2	3	4	5	NO
The platoon complies within higher's fire distribution scheme.	1	2	3	4	5	NO
Tanks engage targets in sequence per danger classification.	1	2	3	4	5	NO
Tanks engage targets in sequence from near to far.	1	2	3	4	5	NO
The platoon engages targets at a rate (volume of fire) appropriate to the tactical situation.	1	2	3	4	5	NO
The platoon shifts/ceases fires when appropriate.	1	2	3	4	5	NO

Platoon

COMMUNICATION

Radio communication (internally and externally) complies with proper Radio-Telephone Procedure (RTP) (i.e., operators correctly use PROWORDS, brevity codes, ciphers, and SOP). Transmissions are clear and concise. The network control station (NCS) effectively maintains network discipline. Radio security equipment, visual communication, wire communications, and messengers are used when possible to reduce the platoon's electronic signature. Transmissions, particularly reports, are as timely and accurate as the situation permits.

Rating Scales

	Never	Rarely	Often	Usually	Always	Not Observed
Operators use proper RTP.	1	2	3	4	5	NO
The NCS effectively maintains net discipline.	1	2	3	4	5	NO
Operators transmit clear, concise radio messages.	1	2	3	4	5	NO
The platoon uses radio security equipment if available.	1	2	3	4	5	NO
The platoon uses visual communication when possible.	1	2	3	4	5	NO
The platoon uses wire communications when practical.	1	2	3	4	5	NO
The platoon uses messengers when practical.	1	2	3	4	5	NO
Operators transmit timely, accurate radio messages.	1	2	3	4	5	NO

Platoon Leader/Platoon Sergeant

FIRE PLANNING

The platoon leader/platoon sergeant (Pldr/PSG) orients the platoon to the terrain (e.g., points out key terrain and avenues of approach), designates individual vehicle positions (i.e., primary and supplemental), and sectors for each vehicle position. He designates direct fire control measures (e.g., TRPs, engagement areas) to partition the platoon sector and to provide for mutual support both within the platoon and with adjacent platoon elements. The Pldr/PSG establishes engagement criteria for the platoon. He establishes standing fire patterns and firing techniques based on likely enemy actions. Time permitting, the Pldr/PSG consolidates a platoon fire plan. He verifies that individual crews/crew members understand the platoon fire plan, how their tank supports the platoon plan, and are properly oriented to the terrain.

Rating Scales

	Never	Rarely	Often	Usually	Always	Not Observed
The Pldr/PSG orients the platoon to the terrain.	1	2	3	4	5	NO
The Pldr/PSG designates primary and supplemental positions for each tank.	1	2	3	4	5	NO
The Pldr/PSG designates individual sectors for each primary and supplemental vehicle position.	1	2	3	4	5	NO
The Pldr/PSG designates direct fire control measures appropriate to the tactical situation.	1	2	3	4	5	NO
The Pldr/PSG plans for mutual direct fire support both within the platoon and with adjacent platoons.	1	2	3	4	5	NO
The Pldr/PSG documents the platoon fire plan if time permits.	1	2	3	4	5	NO
The Pldr/PSG verifies sector coverage from turret down and hull down positions.	1	2	3	4	5	NO

Platoon Leader/Platoon Sergeant

FIRE COMMANDS

The platoon leader/platoon sergeant (Pldr/PSG) uses fire commands to control and coordinate the platoon's direct fires. The Pldr/PSG transmits only the minimum essential information required to bring appropriate fires on the enemy formation or position (e.g., if a standing fire pattern is in effect, no fire pattern is given in the platoon fire command). The specified fire pattern and firing technique are appropriate to the tactical situation.

Rating Scales

	Never	Rarely	Often	Usually	Always	Not Observed
The Pldr/PSG issues clear, concise fire commands.	1	2	3	4	5	NO
The Pldr/PSG selects fire patterns and firing techniques appropriate to the tactical situation.	1	2	3	4	5	NO
The Pldr/PSG effectively controls and coordinates platoon fires.	1	2	3	4	5	NO

Platoon Leader/Platoon Sergeant

REQUEST INDIRECT FIRES

Indirect fires are coordinated with the platoon's own movement and fires. Fires are preplanned to the extent possible. Fires may be controlled by the company team commander through the FIST. The platoon leader/platoon sergeant (Pldr/PSG) may request or shift fires as required during the operation, particularly if the CO and/or FIST cannot observe as effectively as the Pldr/PSG. The Pldr/PSG plans for and requests indirect fires regardless of their expected availability.

In the offense, indirect fires are used to suppress known and/or suspected enemy positions and to reinforce direct fires. Indirect smoke is employed to screen the platoon from enemy observation and fires.

In the defense, the Pldr/PSG employs indirect fires to reinforce direct fires, to force the enemy formation to "button up," and to suppress enemy overwatch positions. Fires and smoke are used to cover movement from one battle position to the next.

Rating Scales

	Never	Rarely	Often	Usually	Always	Not Observed
The Pldr/PSG designates indirect fire control measures appropriate to the tactical situation.	1	2	3	4	5	NO
The Pldr/PSG makes clear, concise, and accurate FA/Mort calls for fire.	1	2	3	4	5	NO
The Pldr/PSG effectively uses FA/Mort fires when available to suppress enemy positions/formations and/or to reinforce direct fires.	1	2	3	4	5	NO
The Pldr/PSG effectively uses FA/Mort smoke when available to screen the platoon from enemy observation and fires.	1	2	3	4	5	NO
The Pldr/PSG shifts FA/Mort fires in coordination with the platoon's movement and fires.	1	2	3	4	5	NO

Platoon Leader/Platoon Sergeant

OPERATIONS ORDERS

Operations orders are clear and concise. The platoon leader/platoon sergeant (Pldr/PSG) conveys all essential information for the upcoming operation in the OPORD format. He omits any non-essential information from the company team or higher level OPORD. The scheme of maneuver conforms with the company team commander's intent and allows for mutual support within the platoon and with adjacent elements. Designated routes make maximum (practical) use of cover and concealment within the boundaries specified by the company commander. The order specifies how known and likely enemy positions will be attacked (offensive) or how likely enemy actions will be countered (defensive). The Pldr/PSG also addresses practical contingencies.

Rating Scales

	Never	Rarely	Often	Usually	Always	Not Observed
The Pldr/PSG issues clear, concise OPORDS.	1	2	3	4	5	NO
The Pldr/PSG communicates all essential information (excludes non-essential information) in OPORD format.	1	2	3	4	5	NO

The Pldr/PSG communicates a scheme of maneuver that:

	Never	Rarely	Often	Usually	Always	Not Observed
conforms with the company team commander's intent.	1	2	3	4	5	NO
provides for mutual support within the platoon and with adjacent platoons.	1	2	3	4	5	NO
effectively uses cover and concealment without violating the company team commander's scheme of maneuver.	1	2	3	4	5	NO
The Pldr/PSG explains how the platoon will react to known/likely enemy actions.	1	2	3	4	5	NO
The Pldr/PSG addresses practical contingencies.	1	2	3	4	5	NO

Platoon Leader/Platoon Sergeant

FRAGMENTARY ORDERS

FRAGOs are used to change or refine the standing order or plan. FRAGOs are not employed arbitrarily when the standing order or plan is sufficient for the existing situation. FRAGOs may be used to prompt preplanned actions when necessary. Actions directed in FRAGOs conform with the commander's intent for the current operation. FRAGOs may be in response to enemy activity or company team FRAGOs. FRAGOs are clear, concise, and timely.

Rating Scales

	Never	Rarely	Often	Usually	Always	Not Observed
The Pldr/PSG issues FRAGOs only when necessary to refine or modify the standing order or plan.	1	2	3	4	5	NO
The Pldr/PSG directs actions by FRAGO that comply with the commander's intent.	1	2	3	4	5	NO
The Pldr/PSG issues clear, concise, and timely FRAGOs.	1	2	3	4	5	NO

Platoon Leader/Platoon Sergeant

SUPERVISION

The platoon leader/platoon sergeant (Pldr/PSG) questions and rehearses subordinates to ensure that orders are received and understood. Subordinates' activities are monitored during preparation and execution to ensure mission accomplishment. The Pldr/PSG corrects subordinates when he observes performance deficiencies. Corrective actions are brief and specific to demonstrated deficiencies. The amount of supervision exercised is adjusted based upon the capability of subordinates: the Pldr/PSG neither over-controls proficient crews nor under-controls novice crews.

Rating Scales

	Never	Rarely	Often	Usually	Always	Not Observed
The Pldr/PSG verifies subordinates' understanding of critical information (e.g., key events, terrain orientation, control measures).	1	2	3	4	5	NO
The Pldr/PSG resolves likely problems during OPORDs, rehearsals, inspections, and/or back-briefings.	1	2	3	4	5	NO
The Pldr/PSG monitors subordinates during execution and corrects deficiencies as soon as practicable.	1	2	3	4	5	NO
The Pldr/PSG issues clear, concise, and specific directives to correct demonstrated deficiencies.	1	2	3	4	5	NO
The Pldr/PSG uses situational leadership (i.e., exercises the amount of supervision appropriate to subordinates' demonstrated capabilities).	1	2	3	4	5	NO

Appendix C

Rater Training for Crew, Platoon, and Platoon Leader BDS

CONTENTS

In the workshop instructions, unmodified text is to be read by the workshop leader. **Highlighted text relates action the workshop leader should take.** Text in small print is a replication of information on the hand-outs given to workshop participants.

Workshop Instructions

Project Overview and Workshop Purpose

We have developed tests of crew and platoon gunnery for use under instrumented dry fire or MILES testing conditions or even live fire conditions. The scores from these tests are to be used for training research purposes. All of you are familiar with the Table VIII and Table XII scoring processes. For Table VIII, crews are scored on the speed and accuracy of targets hit. Any procedural errors or crew duties penalty points are subtracted from the speed and accuracy score to yield an overall score. For Table XII, platoons are scored on the number of targets hit within a certain time limit. The evaluator scores tactics and procedures by using a checklist, and platoons receive a separate gunnery and tactical proficiency score.

We are not attempting to replace Table VIII or Table XII testing. We're interested in augmenting Table VIII and XII data with data from some new tests we've developed. We are interested in the same kinds of scores obtained in Tables VIII and XII (i.e., speed and accuracy of target hits, number of targets hit, and tactics and procedures). We'll obtain the speed and accuracy scores in much the same way that Tables VIII and XII do; however, we'll obtain the tactics and procedures score in a different way. Specifically, in scoring tactics and procedures, we'll use rating scales instead of a checklist. The rating scales were developed by armor experts like yourselves. As currently used, the checklists are completed after each exercise. The rating scales, on the other hand, will be used to summarize tactics and procedures across several engagements.

Each crew and platoon will receive two scores: (a) a gunnery score which reflects the speed and accuracy of target hits and (b) a process score which reflects the tactics and procedures used in hitting those targets. Platoon leaders will receive only a process score. One evaluator will record the number of targets hit and the time required to hit those targets. Your job will be to score the tactics and procedures of each crew, platoon, and platoon leader.

This workshop will focus only on process scoring and the rating scales you'll be using to derive those scores. The purpose of this workshop is twofold. One goal is to familiarize you with the scales you will be using to evaluate crew, platoon, and platoon leader tactics and procedures. Some of the rating scales you'll use incorporate a lot of information. Given the somewhat chaotic nature of gunnery exercises (i.e., a lot happens at once), you won't have time to simultaneously observe performance, thoroughly read the scales, and make your ratings. We want you to be very familiar with the rating scales for two reasons. First, by being familiar with the scales, you can spend less time trying to figure out what performance is covered by each scale and more of your time observing performance during an engagement. Second, by knowing which behaviors you will be rating, you'll know which behaviors to look for during the engagement. Because the scales will be completed after <u>several</u> engagements rather than after <u>each</u> engagement, we've designed engagement worksheets to help you keep track of what happens during each engagement. However to use the engagement worksheets effectively, it is very important that you are extremely familiar with the behaviors covered by each rating scale.

The second goal of this workshop is to provide rater training. When rating the performance of others, we all have a tendency to make certain errors. We want you to be aware of these errors so hopefully you can avoid making them when assigning your ratings.

Do you have any questions so far?

Behavioral Description Scale Content Review

Crew, platoon, and platoon leader process performance will be evaluated on several categories. This hand-out lists the categories on which they will be evaluated. [Distribute Hand-Out 1.] A Behavioral Description Scale (BDS) has been developed for each category. As you can see from the Hand-Out, there are eight scales for evaluating crew processes, eight for evaluating platoon processes, and six for platoon leader processes.

Crew Scale Categories
1. Search Procedure
2. Acquisition Reports
3. Normal Mode Fire Commands and Reengagement
4. Degraded Mode and Subsequent Fire Commands
5. Movement
6. Reaction Drills
7. Contact Reports
8. Spot Reports

Platoon Scale Categories
1. Route Selection
2. Movement
3. Position Selection
4. Intra-Position Movement
5. Orientation (Defense)
6. Orientation (Offense)
7. Direct Fires
8. Communication

Platoon Leader Scale Categories
1. Fire Planning
2. Fire Commands
3. Request Indirect Fires
4. Operations Orders
5. Fragmentary Orders
6. Supervision

As we start working with these categories, many of the behaviors we'll be discussing will seem applicable to more than one category. Many categories seem to overlap due to the nature of gunnery and the way gunnery skills are trained. There are two aspects of overlap among categories. One aspect concerns differences between levels of analysis. That is, differences encountered when measuring crew versus platoon performance. For example, search procedures are part of platoon orientation; however, search procedure is a crew level task. In rating platoon orientation, we're evaluating a platoon process. Although individual crew performance contributes to platoon orientation, we're primarily concerned with the composite platoon evaluation when we rate platoon orientation instead of individual crew performance.

A second aspect of category overlap involves the interrelationships among categories within a level of analysis. For example, several platoon categories refer to use of cover and concealment in different contexts. Route Selection and Position Selection are concerned with the amount of cover and concealment afforded the platoon as a whole. Intra-Position Movement

addresses the paths individual vehicles select given the platoon's axis or position. The evaluator must consider whether a failure in use of cover and concealment is based upon inadequate terrain for the platoon (i.e., poor Route Selection) or individual crew failure (i.e., poor Intra-Position Movement).

In developing these rating scales, we attempted to sort out the interrelationships among behaviors across categories. One could argue that platoon movement incorporates route selection, position selection, and intra-position movement. Many of these movement aspects will not apply to all engagements, but several will apply to every engagement. For example, route selection is not likely to apply in a defensive engagement; however position selection is likely to be applicable in every engagement. To make the evaluator's job easier, we developed separate scales for each of these aspects of platoon movement.

You are all armor experts so you have some idea of the behaviors that are included in each category. However because of overlap in gunnery skills, there may be some discrepancy regarding what you assume is included in each category, what someone else assumes is included, and what is actually included. To make sure that we're all on the same sheet of music, we'll walk through each category and review the behaviors covered by each scale.

I'm passing out three rating scale packets--one for Crew, one for Platoon, and one for Platoon Leader/Platoon Sergeant. [Distribute rating scales as they appear in Appendix B.] The rating scale for each category appears on a separate page in these packets. The category title is at the top of each page and is followed by a short summary of the performance facets covered by that category. Beneath that is a rating scale for each facet covered by the category. For each facet, you will rate the frequency with which it was performed by the crew, platoon, or platoon leader. The far right column, "Not Observed," is used if performance on that facet was not observed during the exercise being evaluated. Please note that our use of the term "platoon leader" refers to both the platoon sergeant and the platoon leader.

Do you have any questions about the BDS format?

<u>Crew BDS review</u>. In reviewing the content of each BDS, let's start with the Crew scales. Before looking at the actual content of the scales, try to think of the various aspects of performance that might be covered by each scale. After identifying aspects that might be covered, we'll read the scale to determine the aspects that actually are covered. The first BDS is Search Procedure. Before reading the scale, which behaviors do you think should be covered by the crew category Search Procedure? [Give SMEs an opportunity to identify behaviors. Write down their suggestions. Suggestions don't need to be written on a board or flip chart. These notes are primarily for your own reference. Some behaviors they suggest may be covered by other BDS. Write down those suggestions, too.] Now, take a few minutes to read the summary and each facet. [Wait a few minutes while the SMEs do this.] As you can see, some (or all) of the areas addressed by the category are the areas you suggested should be covered. The scale addresses five facets of Search Procedure: (a) searching between and during engagements, (b) primary sector coverage, (c) 360° security, (d) crew members search their entire sectors and make detailed searches of danger areas, and (e) use of binoculars or night vision goggles. [Indicate correspondence between the aspects they suggested and those that are on the scale. Draw particular attention to any aspects

they may have omitted. For their suggestions that are not included in Search Procedure, point out that although they could be covered under Search Procedure they're covered in another BDS.]

Regardless of what you personally feel should be covered by the category Search Procedure, it is critical that you rate crews only on those behaviors included in our rating scale. The reason this is so important is so we can compare ratings from one crew to another. If you rate crews on certain behaviors and another evaluator rates crews on a different set of behaviors, we have no way of comparing the two scores. In order to compare ratings across crews, the ratings must be standardized (i.e., all crews must be rated on the same behaviors).

Do you have any questions about the behaviors covered in the Search Procedure BDS?

[Follow the same procedure for reviewing the remaining Crew BDS. Stress the importance of understanding exactly what's covered in each BDS. The aspects of the remaining Crew BDS are as follows:

Acquisition Reports: (a) timeliness, (b) brevity, (c) target description accuracy, (d) target location accuracy.

Normal Mode Fire Commands and Reengagement: (a) timeliness, (b) brevity and comprehensiveness, (c) ammunition selection, (d) target selection and sequencing, (e) target description accuracy, (f) corrections, (g) timeliness and accuracy of crew verbal responses, (h) reengagement.

Degraded Mode and Subsequent Fire Commands: (a) timeliness of degraded mode fire commands, (b) brevity, comprehensiveness, accuracy per degraded mode condition, (c) ammunition selection, (d) battlesight used when appropriate, (e) target selection and sequencing, (f) brevity and effectiveness of direction element, (g) fire command accuracy, (h) corrections, (i) timeliness and accuracy of crew verbal responses, (j) standard adjustments/subsequent fire commands per crew/adjacent tank observations, (k) time to isolate, correct, compensate for degraded condition.

Movement: (a) use of covered and concealed routes, smoke, and weather, (b) movement coordination with other tanks in platoon/section, (c) selection of primary, alternate, and supplemental positions, (d) occupation and movement between hide, turret down, and hull down positions, (e) avoiding effective anti-tank fires, (f) maintaining steady firing platform and tank's speed, (g) avoiding untrafficable terrain.

Reaction Drills: (a) immediacy of reaction to enemy contact or drill, (b) return of fire on contact, (c) change of direction or turret orientation per drill or situation, (d) avoiding effective anti-tank fires.

Contact Reports: (a) immediacy, (b) direction and target description accuracy, (c) brevity, (d) clarity.

Spot Reports: (a) accuracy of type, number, and actions of vehicles, (b) accuracy of time of sighting or engagement, (c) location accuracy, (d) friendly response accuracy, (e) timeliness.]

<u>Platoon BDS review</u>. Now we'll review the Platoon BDS. The first BDS is Route Selection. Which behaviors do you think should be covered by the platoon category Route Selection? [Give SMEs an opportunity to identify

behaviors, and write down their suggestions. Remember that some suggested behaviors may be covered by other BDS, but write them down anyway.] Now, take a few minutes to read the summary and each facet. [Wait a few minutes while the SMEs do this.] Some (or all) of the areas addressed on the scale are the areas you suggested should be covered. The facets address: (a) appropriateness of route, (b) cover and concealment, (c) use of reduced visibility, and (d) avoidance of untrafficable terrain. [Indicate overlap between the aspects on the scale and those they suggested. Draw attention to any aspects they may have omitted. For suggestions that are not included in Route Selection, point out that although they could be covered in this BDS they're covered elsewhere.]

Do you have any questions about the behaviors covered in the Route Selection BDS?

[Follow the same procedure for reviewing the remaining Platoon BDS. Stress the importance of understanding exactly what's covered in each BDS. The aspects of the remaining Platoon BDS are as follows:

Movement: (a) suitability for technique and formation, (b) formation maintenance, (c) adjustment to terrain, (d) suitability of rate of movement, (e) bound limited by overwatch effectiveness, (f) speed of direction/formation change.

Position Selection: (a) suitability of battle/overwatch positions, (b) adequacy of observation and fields of fire, (c) primary, alternate, and supplementary position selection, (d) adequacy of cover and concealment, (e) room for independent maneuver.

Intra-Position Movement: (a) proper occupation of hide, turret down, or hull down positions, (b) coordination of movement and fires, (c) duration of tank exposure in firing position, (d) movement to avoid decisive engagement, (e) movement between fighting positions - use of speed and covered and concealed routes, (f) rehearsal of movement between positions, (g) compliance with movement restrictions.

Orientation (Defense): (a) convergency of primary sector coverage, (b) mutual support within platoon, (c) maintenance of all-round security, (d) compliance with REDCON, (e) action on contact.

Orientation (Offense): (a) orientation on primary threat, (b) orientation per sector/platoon formation, (c) mutual support within and without platoon, (d) continuity of overwatch, (e) shifting of overwatch in coordination with bounding element, (f) immediacy of return fire on contact, (g) immediacy of contact reports, (h) rapidity of platoon drill on contact.

Direct Fires: (a) fire distribution, (b) compliance with higher's fire distribution scheme, (c) engagement sequence per target classification, (d) engagement sequence per target range, (e) suitability of volume of fires, (f) suitability of shift/cease fire.

Communication: (a) use of RTP, (b) maintaining net discipline, (c) clarity and brevity of radio messages, (d) use of transmission security equipment, (e) use of visual communication, (f) use of wire communication, (g) use of messengers, (h) timeliness and accuracy of radio messages.]

<u>Platoon Leader/Platoon Sergeant BDS review</u>. We'll now review the Platoon Leader/Platoon Sergeant (Pldr/PSG) BDS. The first BDS is Fire Planning. Which behaviors do you think should be covered by the Pldr/PSG

category Fire Planning? [Allow SMEs to identify behaviors, and jot down their suggestions. Although some suggested behaviors may be covered by other BDS, note them anyway.] Now, take a few minutes to read the summary and each facet. [Wait for SMEs do this.] Some (or all) of the areas addressed on the scale are the areas you suggested should be covered. The facets address: (a) orientation to terrain, (b) orientation of tank positions, (c) designation of tank sectors, (d) designation of direct fire control measures, (e) provision for mutual support, (f) documentation of fire plan, and (g) verification of sector coverage from fighting positions. [Indicate correspondence between aspects on the scale and those that were suggested. Specifically, point out any aspects they may have omitted. For suggestions that are not included in Fire Planning, indicate that although they could be covered here they're covered in another BDS.]

Do you have any questions about the behaviors covered in the Fire Planning BDS?

[Follow the same procedure for reviewing the remaining Platoon Leader/Platoon Sergeant BDS. Stress the importance of understanding exactly what's covered in each BDS. The aspects of the remaining Platoon Leader/Platoon Sergeant BDS are as follows:

Fire Commands: (a) clarity and brevity, (b) suitability of fire pattern and technique, (c) effectiveness of fire commands.
Request Indirect Fires: (a) designation of indirect fire control measures, (b) clarity, brevity, and accuracy of requests, (c) use of indirect fires for suppression and/or to reinforce direct fires, (d) use of indirect smoke, (e) coordination of indirect with platoon movement and fires.
Operations Orders: (a) clarity and brevity, (b) format and inclusion of essential information, (c) compliance with commander's intent, (d) provision for mutual support, (e) consideration of cover and concealment, (f) accommodation for known/likely enemy disposition, (g) contingency planning.
Fragmentary Orders: (a) used only when necessary to refine/modify existing plan, (b) conformity with commander's intent, (c) clarity, brevity, and timeliness.
Supervision: (a) questioning subordinates to insure understanding of plans/orders, (b) resolution of problems in OPORD, rehearsals, inspection, back-briefing, (c) monitoring/correcting subordinates during execution, (d) clarity, brevity, specificity of corrective actions, (e) use of situational supervision levels.

Now that you're very familiar with the BDS and the performance covered by each, we'll take a break. After the break, we'll discuss how to use the engagement worksheets and errors raters tend to make. Then you'll have an opportunity to practice using the worksheets to make some ratings.

BREAK

Exercise Worksheets

During test development, engagements were grouped for summary process scoring. Engagement conditions for the clustered engagements were then analyzed to determine the BDS that are to be completed for each cluster. For example, all day engagements were clustered, and the applicable BDS identified. Thus, you'll follow a crew or platoon until it has completed all the day engagements. Then you will summarize the crew or platoon's process performance across all day engagements by providing a single rating for each applicable BDS.

While a crew or platoon is engaged, your primary job is to observe its behavior. If evaluating a platoon, you also want to watch the platoon leader's actions. Given that you will be rating a crew, for example, across several engagements on several BDS, it is extremely important that you are very familiar with the BDS so you can focus on performance rather than on reading the BDS during each engagement. It is even more important that you are very familiar with Platoon and Platoon Leader/Platoon Sergeant BDS. First, you'll have to observe both the platoon and the platoon leader across several engagements. Second, 8 Platoon BDS and 6 Platoon Leader/Platoon Sergeant BDS for a total of 12 BDS must be completed compared to 8 Crew BDS.

Due to the comprehensive nature of the BDS, a worksheet has been developed for each engagement to assist you in making your summary ratings. [Distribute Engagement Worksheets.] As you can see, at the top of each worksheet is a short, descriptive title for the engagement followed by the engagement conditions. The rating categories are listed next. For each rating category, key behaviors covered by the category are outlined. As you observe an engagement, you can make shorthand notes regarding the crew, platoon, or platoon leader's performance on each rating category. In addition, space is provided for more detailed notes.

For each exercise, you may complete several engagement worksheets. When a crew or platoon completes an exercise, you will review your worksheets and assign a summary rating for each applicable BDS category.

Rater Error Training

As you review your worksheets in preparation for assigning ratings, you must first decide which statement best describes each crew, platoon, or platoon leader's <u>most typical</u> performance during the exercise. Then select the number that best describes the crew, platoon, or platoon leader's performance. Record your rating by circling the appropriate number. The main point is that for each category, you are to compare your observations of each crew, platoon, or platoon leader's behavior and performance to the performance statements on the rating scale and then select the rating that best reflects their performance <u>most</u> of the time during the exercise. Suppose you're rating a platoon on Orientation (Defense). Let's say that three tanks were always concentrating their searches in their primary sectors, but one was rarely properly oriented. The primary sector coverage would be about 75-80%, which corresponds to a rating of 3 or 4.

When rating the performance of others, we all have the tendency to make several rating errors. So I'd like to take a few minutes to review with you four very common rating errors so that you will hopefully be able to avoid these when you make your evaluations.

One type of error occurs when a rater has a general good or bad impression of the crew, platoon, or platoon leader he is evaluating and this impression tends to influence all of his ratings for that crew, platoon, or platoon leader. This is called "halo" error. Halo error is most likely to occur when an evaluator knows the person or persons being evaluated very well. However, it is possible to form a general impression with very little exposure to a crew, platoon, or platoon leader and thus be likely to commit halo error. For example, a platoon may seem unorganized prior to running an exercise so you assume it won't perform well. Its performance during the exercise may be average or better, but because of your negative first impression, you give the platoon below average ratings on many categories.

You're making halo error if you give a crew, platoon, or platoon leader the same rating in several categories. For example, if you give a crew a "5" on several or all of the Crew BDS, you're making halo error. Now, it's very unlikely that a crew, platoon, or platoon leader performs at the exact same level in all eight crew categories, eight platoon categories, or six platoon leader/platoon sergeant categories. Instead, most crews, platoons, and platoon leaders perform well in some categories and less well in others. Your ratings should show each crew, platoon, and platoon leader's strengths and weaknesses.

Another thing that leads to rating errors is that sometimes raters tend to think about only the most recent incident they have observed when they are deciding on a rating. For example, let's say that during an exercise a platoon changed formation several times. Most of their formation changes were well-executed; however, their last formation change was sloppy. So, when you get to the platoon category Change in Formation, you remember that final formation change and rate the platoon a "2." However, what we want you to do is think about the platoon's most typical or average performance in each area during the exercise. Be sure that your rating reflects the most typical performance as opposed to only the last incident you can remember. Using the engagement worksheet will help prevent this error. In the above example, a completed worksheet would have reminded the rater that several formation changes were well executed compared to one that was poorly executed.

The third error that raters often make is to allow things that have nothing to do with performance to influence their ratings. For example, someone's family background, education, previous experience, or whether or not you're good friends may lead you to rate the person in certain ways--either high or low. Like halo error, this error is most likely to occur when the evaluator knows the crew, platoon, or platoon leader being evaluated. We want you to base your ratings only on what you have observed during each exercise. Forget about all the other things that have nothing to do with actual performance.

Finally, don't give all crews, platoons, or platoon leaders the same rating within a category. Instead, your ratings should indicate who is performing effectively and who is performing less effectively within each category. Giving all crews, platoons, or platoon leaders the same rating

within a category is called same-level-of-effectiveness or same-level-of-performance error. You're making this type of error, for example, when you give several or all platoon leaders a "2" on Fire Planning, a "5" on Communication, and a "4" on Request Indirect Fires. Now, it's very unlikely that all of the crews, platoons, or platoon leaders you're rating perform at the same level within a given category. Thus your ratings should show who is performing well and who is not performing well within each category.

Now that I've gone through these four errors, there's one final point that I want to stress again. Although these errors are important and you should be aware of them, the most important thing is that you rate each crew, platoon, or platoon leader accurately. If you really believe, for example, that three of the crews, platoons, or platoon leaders should be given the same rating in a category or that one crew, platoon, or platoon leader performs at, let's say, the "4" level in several categories, then you should rate them in this way. However, when differences exist between crews, platoons, or platoon leaders you're rating and when strengths and weaknesses in the different areas of performance are evident for a crew, platoon, or platoon leader, then your ratings should reflect these differences.

Are there any questions about the four types of rating errors or what you're being asked to do?

Rating Practice

Because of the amount of overlap and the degree of detail in the scales, it's often difficult to separate the BDS in our minds. What I'd like to do now is have you work through a few samples to give you practice using the BDS. The samples consists of descriptions of a crew, platoon, or platoon leader's performance on an exercise. We'll rate a couple of crew examples using the Crew BDS and a couple of platoon examples using the Platoon and Platoon Leader/Platoon Sergeant BDS. In working through these examples, you'll have an opportunity to practice using the worksheets and translating worksheet notes to summary ratings.

Crew BDS Practice. [Distribute Hand-Out 2.] I'm passing out sample descriptions of a crew's performance on two crew engagements. We'll use these to make practice ratings on the CREW BDS.

Skim the first example, and try to identify the rating scales that are applicable to this example. [Give SMEs a chance to do this.] Which scales do you think are applicable? [Allow the participants to state their opinions. You don't need to make any notes of the discussion.] Here are the engagement worksheets for the first example. [Distribute Hand-Out 3 - Applicable Engagement Worksheets for Crew Example 1.]

Now skim the second example, and identify the applicable rating scales. [Give SMEs a few minutes to do this.] Which scales do you think are applicable? [Allow the participants to state their opinions. You don't need to make any notes of the discussion.] Here are the engagement worksheets for the second example. [Distribute Hand-Out 4 - Applicable Engagement Worksheets for Crew Example 2.]

Read both examples. As you read, use the worksheets to make any necessary notes. When you've finished reading and taking notes, transfer your notes into a summary rating on each of the applicable Crew BDS. Record your summary ratings on the Crew BDS we've been working with today. [Show Crew BDS to make sure everyone's with you. Give SMEs time to complete their ratings.]

In rating the performance described in these examples, we don't expect all of you to make exactly the same rating on every scale. In other words, everyone's not expected to provide a rating of 3 on ___________ [applicable crew criterion], 5 on _____________ [applicable crew criterion], 2 on ____________ [applicable crew criterion], and so forth. However, your ratings should be fairly close. Maybe your ratings range from 1 to 2 on ___________, 2 to 3 on ___________, and 4 to 5 on ___________. Let's walk through the scales and identify aspects of the crew's performance that caused you to rate them as you did. That is, if the average group rating for ___________ is a 2, what in the crew's performance lead you to make that rating? [Similarly discuss ratings on the remaining scales.]

Platoon and Platoon Leader/Platoon Sergeant BDS Practice. This hand-out contains descriptions of a platoon and platoon leader's performance on two sample engagements. [Distribute Hand-Out 5.] Take a few minutes to glance over the first example. Which scales do you think are appropriate given this scenario? [Allow SMEs to state their opinions, but you don't need to take any notes.] These are the engagement worksheets for this example. [Distribute Hand-Out 6 - Applicable Engagement Worksheets for Platoon and Platoon Leader/Platoon Sergeant Example 1.]

Now look at the second example, and identify the applicable rating scales. [Give SMEs a few minutes to do this.] Which scales do you think are applicable? [Allow the participants to state their opinions. You don't need to make any notes of the discussion.] Here are the engagement worksheets for the second example. [Distribute Hand-Out 7 - Applicable Engagement Worksheets for Platoon and Platoon Leader/Platoon Sergeant Example 2.]

As with the crew examples, we'll use these examples to make practice ratings on the Platoon and Platoon Leader/Platoon Sergeant BDS. Take a few minutes to read the both examples, and make notes on the worksheets. Then summarize those notes into a single rating on the applicable BDS. [Show Platoon and Platoon Leader/Platoon Sergeant BDS to make sure everyone's on the same sheet of music. Give SMEs time to make their ratings. Then discuss their ratings as you did for crew BDS practice.]

Final Comments

Are there any questions about anything we've covered today? Anything about what's covered by the BDS? Any questions about the worksheets and how to use them to make summary ratings? Any questions about the four types of rating errors?

For each crew, platoon, and platoon leader you evaluate, you'll need to complete a "background information form." The form is self-explanatory so we won't go into it in any detail today. Basically it asks typical "background" information: the evaluator's name, rank, unit; the crew, platoon, or platoon leader's unit; etc. This information will be used for research purposes only.

Annex 1

BDS Categories for Assessing Crew, Platoon, and Platoon Leader Processes

<u>Crew Scale Categories</u>
1. Search Procedure
2. Acquisition Reports
3. Normal Mode Fire Commands and Reengagement
4. Degraded Mode and Subsequent Fire Commands
5. Movement
6. Reaction Drills
7. Contact Reports
8. Spot Reports

<u>Platoon Scale Categories</u>
1. Route Selection
2. Movement
3. Position Selection
4. Intra-Position Movement
5. Orientation (Defense)
6. Orientation (Offense)
7. Direct Fires
8. Communication

<u>Platoon Leader/Platoon Sergeant Scale Categories</u>
1. Fire Planning
2. Fire Commands
3. Request Indirect Fires
4. Operations Orders
5. Fragmentary Orders
6. Supervision

Annex 2

Crew BDS
Practice Examples

Crew Engagement Example 1

You are the TCE for a crew involved in a live fire gunnery exercise. You are aboard the tank using a fifth man hook-up to the intercom and a jump radio on the range admin frequency. You can hear all crew intercom transmissions, radio transmissions on the firing net (representing the platoon frequency), and the admin net. Only you can monitor the admin net, thus the tower operator uses that frequency to inform you when targets are up and to report hits and misses. He also informs you at 5 second increments in exposure time during the engagement.

The first engagement is from a defensive position. Two tank frontal silhouettes (T-72 frontal engagements) are presented--the left silhouette at about 1200 meters, the right at about 1450. The (notional) platoon battle carry configuration was APFSDS-T, 1200 meters indexed. The crew has already received a warning over the platoon network that enemy contact is imminent. They have already moved from a hide position to a turret down position. The crew is searching as follows:

DRIVER: Masked by terrain.
GUNNER: Rotating turret within tank's primary sector as defined by the range fan markers of the live-fire range. The tank is in normal mode, GPS/daylight channel. The TIS is cooled down and on stand-by.
LOADER: Searching from the open hatch concerned primarily with the area down range (primary sector). Occasionally glancing to the left side of the tank.
TC: Searching down range with binoculars. About 30 seconds after the spot report was received, he dropped his binoculars and glanced to the rear of the tank. Something caught and held his attention to the rear for about 10 seconds.

As the TC turned around again, smoke and simulated artillery fire appeared 400 meters to his immediate front. You observe and hear the following:

GUNNER: "SMOKE--DIRECT FRONT. SWITCHING TO TIS."
TC: Grabbed his map, thought for a moment, then entered the platoon net: "RED ONE THIS IS RED TWO. SPOT REPORT. OVER."
TOWER: "THIS IS RED ONE. SEND IT. OVER."
TC: "SMOKE AND ARTILLERY IMPACTING AT [GRID]. CONTINUING TO OBSERVE. OVER."
TOWER: "ROGER OUT."

The grid for the spot report was probably within 50 meters of the actual location. As the TC gave the spot report, you signalled the tower to present the target. There was a slight delay; then the tower operator informed you that the targets were up. The gunner suddenly jerked the turret to the left a few degrees.

GUNNER: "TANK DIRECT FRONT."
"CORRECTION--TWO TANKS."
LOADER: Dropped down into the turret and prepared to arm the main gun.
TC: Squatted down, glanced through the GPSE, and announced: "GUNNER--SABOT--TWO TANKS--RIGHT TANK FIRST."
LOADER: Armed the main gun and announced: "UP."
GUNNER: Switched the trigger to the main gun position and announced: "IDENTIFIED."
TC: "DRIVER, MOVE OUT. GUNNER, TAKE OVER."
GUNNER: Leaned over to the GAS as the tank moved forward into the hull down position. As the tank moved into correct position, announced: "DRIVER, STOP."
DRIVER: Slowed the tank to a smooth stop about 2 meters forward of what was marked on the ground as the optimum hull down position.

You started the "engagement time" as the tank pulled into position. The targets had been exposed about 13 seconds by the time the tank got into position. There was a few seconds delay. Then . . .

TC: Reached over to his control panel and hit the battle range button. He looked into the GPSE again and announced: "FIRE."
GUNNER: "ON THE WAY." Fired the first round 4 seconds after the tank stopped in the firing position. "LOST."
TC: "LOST." simultaneously with gunner's announcement.
LOADER: Began reloading the main gun.
TOWER: "SHORT."
GUNNER: "REENGAGING."
TC: (Immediately) "NEGATIVE! DO NOT RELASE! DROP TWO. CORRECTION--SHORT. ADD ONE."
LOADER: Armed the main gun and announced: "UP."
TC: "FIRE."
GUNNER: "ON THE WAY." Fired the second round 6 seconds after the first.
TC: "TARGET, . . ."
GUNNER: (Simultaneously) "TARGET."
TOWER: "TARGET."
TC: Grabbed the override, traversed the turret to the left, announced: "BATTLESIGHT LEFT TANK," and let go of the override.
GUNNER: "IDENTIFIED." Made his final lay on the closer target.
LOADER: Finished reloading and announced: "UP."
TC: "FIRE."
GUNNER: "ON THE WAY." Fired the third round about 8 seconds after the second round (18 seconds engagement time). "TARGET."

TC: "CEASE FIRE. DRIVER, BACK UP. BATTLE CARRY SABOT." Then he stood up in the hatch and proceeded to direct the driver back into the turret down position. When the tank stopped, the TC slowly scanned the area from the rear of the tank back around the right side and to the front.
GUNNER: "SABOT INDEXED." Resumed his search of the primary sector.
LOADER: "SABOT LOADED."
TC: To platoon net: "RED ONE, THIS IS RED TWO. SPOT REPORT. OVER."
TOWER: "THIS IS RED ONE. SEND IT. OVER."
TC: "ENGAGED AND DESTROYED TWO TANKS, [GRID]. EXPENDED THREE SABOT. CONTINUING TO OBSERVE, REDCON ONE, OVER."
TOWER: "ROGER OUT."

The grid on the targets was within about 100 meters of the actual position of the closer target. At the completion of the engagement, the tower confirmed the following data (all times are <u>exposure</u> time):
All targets confirmed up at 0:02.
Round one short of target two at 0:17.
Round two target on target two at 0:23.
Round three target on target one at 0:31.
Spot Report received at 0:44.

As you were marking down the times, you overheard the following conversation on the intercom:

GUNNER: "Why did you give me a correction rather than have me reengage?"
TC: "Why did you switch to THERMAL?"
GUNNER: "To see through the smoke."
TC: "Does the LRF work through smoke?"
GUNNER: "Uhhhh, . . . no, I guess not. I guess that's why you had me fire battlesight on the second target, too, huh?"
TC: "You got it."
GUNNER: "Then why didn't we start out in battlesight?"
TC: "I was just testing to see if you're ready to TC this pig when I ETS, SMART-@#*."

Crew Engagement Example 2

The same crew proceeded to an offensive engagement. The battlecarry setting was HEAT at 900 meters. The crew was to move from one overwatch position to another. The directions to the crew specified only that they were moving as part of the lead section in a movement to contact and that they were to move to the next checkpoint.

The engagement was initiated when the tank was about half-way between positions. The tank encountered a BMP at 850-1000 meters, an infantry squad at 500-600 meters and to the right of the BMP, and a dismounted ATGM team at 350-500 meters and to the left of the BMP. A suitable defilade position that the tank could occupy was about 100-150 meters downrange from the "trigger line" and about 20 meters off the course road. The crew was not prompted to use it, but neither were they restricted from doing so.

The crew's search behavior was similar to that in the previous example, except the driver was no longer masked by terrain and the TC was focusing uniquely on the downrange area. The tank was in normal mode. The gun/turret drive switch was in the EL UNCPL position.

As the tank crossed the "trigger line," you signalled the tower to present the targets. You observed the first target (BMP) come up and the following crew responses:

TC: Within 1 second of initial target presentation: "GUNNER--HEAT--BMP." Slewed the turret onto the target.
LOADER: Dropped down into the turret and armed the main gun. "UP."
GUNNER: "IDENTIFIED."
DRIVER: "TROOPS--ONE O'CLOCK."
TC: "CORRECTION: GUNNER--HEAT--BMP AND COAX--TROOPS, BMP FIRST, FIRE AND ADJUST."
"DRIVER, SEEK HULL DOWN AT TWO O'CLOCK."
"CALIBER FIFTY."
The TC keys the radio and announces: "CONTACT--EAST"

As the tank turned toward the protected position, the gunner completed his lay on the BMP. The TC unlocked the cupola and traversed the 50 Caliber machine gun onto the ATGM team to the left of the BMP. He had difficulty laying on the target while the tank was moving but did establish and maintain a good, approximate orientation on the ATGM team.

GUNNER: "ON THE WAY." Fired on the BMP in 17 seconds and achieved a first round hit. "TARGET--TROOPS IDENTIFIED." He traversed the turret to the right to engage the infantry squad.
TOWER: (Admin net) "TARGET ON BMP."
DRIVER: Continued to move into the hull down position. When he lost sight of the troops, he began slowing the tank and announced "GUNNER, CHECK MASK."

LOADER: As soon as the first round was fired, he reloaded the main gun with HEAT-TP-T and announced "HEAT LOADED." He left the main gun in the safe position and climbed up into the hatch to observe the machine gun engagements.

GUNNER: Looked through the GAS to clear the terrain mask. Announced "LOADER, DISCONNECT EL UNCOUPLE. DRIVER, STOP." Then returned to the GPS.

LOADER: Crouched down in the turret, reset the gun select switch to the POWERED position, and announced: "UP."

DRIVER: Quickly slowed the tank to a smooth stop.

GUNNER: "ON THE WAY." Opened fire with the coax machine gun 11 seconds after the BMP was destroyed. Fired three bursts. The first was a short burst with only two tracers centered on the troop array. There was about a 2 second delay. The second burst contained five tracers and swept the target array from right to left.

TC: Opened fire on the ATGM team with the M2HB just as the gunner opened on the troops. Fired two bursts. The first burst contained only one tracer and fell short of the target on line. The TC opened with the second burst almost as soon as the first rounds hit the ground. The second burst contained four tracers and was dead on target. He announced: "TC COMPLETE" about 30 seconds into the engagement.

TOWER: (Admin net) "TARGET ON ANTI-TANK."
"SUPPRESSION ON TROOPS."

GUNNER: Continued to engage the troops. The third burst contained 12 tracers and swept from left to right and back to the left of the target array.

TC: "TARGET--CEASE FIRE. BATTLECARRY HEAT." Total engagement time about 35 seconds.

LOADER: "HEAT LOADED."

GUNNER: "HEAT INDEXED."

TC: "DRIVER, REPORT."

DRIVER: "DRIVER READY."

TC: On the platoon net: "RED ONE, THIS IS RED TWO. SPOT REPORT. OVER."

TOWER: "THIS IS RED ONE. SEND IT. OVER."

TC: "ENGAGED AND DESTROYED ONE BMP AT [GRID], TROOPS AT [GRID], AND ANTI-TANK AT [GRID]. TROOPS AND ANTI-TANK SUPPRESSED. TIME NOW. AM STOPPED 800 WEST OF CHARLIE-PAPA TWO-TWO, CONTINUING TO OBSERVE. EXPENDED ONE HEAT, THIRTY MOD-DEUCE, ONE HUNDRED COAX, OVER."

TOWER: "ROGER, COVER MY MOVE. OUT."

As he was reporting, the TC divided his attention between his map, the target area, and a scan of the right side of the tank from about 4 o'clock around to the primary sector. The loader was up in his hatch searching the primary sector and occasionally glancing off to the left side of the tank and to the rear. The turret was moving back and forth within the primary sector. All locations in the spot report were within 50-100 meters of actual positions.

TC: (On intercom): "GUNNER, YOUR LAST BURST WAS TOO LONG. REMEMBER --TWENTY TO THIRTY ROUND BURSTS. THAT'S FOUR TO SIX TRACERS. LOADER, REMEMBER--WHEN YOU HAVE THE MAIN GUN IN SAFE AND THE GUN DRIVE IN EL UNCOUPLE, THE STAB IS DISCONNECTED. YOU HAVE TO RESET ONE OR THE OTHER BEFORE THE GUNNER CAN USE THE COAX IN A STAB ENGAGEMENT. GOOD JOB, DRIVER, ESPECIALLY WHEN YOU REMINDED THE GUNNER TO CLEAR THE LINE OF FIRE."

The tower gave you the following data based upon exposure times.
All targets confirmed up at 0:04.
Contact report at 0:13.
Target on BMP at 0:17.
Coax opened on troops at 0:28, suppression effective at 0:31, closed at 0:35. Five-fifths coverage.
Caliber fifty opened on ATGM team, short, at 0:28; target effect at 0:30, closed at 0:31.
Spot report received at 0:50.

Annex 3

Sample Engagement 1: Engage Multiple Targets (Defense)

CONDITIONS: The tank is in a defensive (turret-down) position, enemy contact is imminent. Battlecarry is SABOT/1200 meters. Artillery HE (simulated) and smoke is delivered to the tank's front 25-30 seconds prior to target presentation. Two stationary T-72 frontal targets are presented, range: 1100-1500 meters for 40 seconds. Engagement is to be fired battlesight/thermal. Three rounds TPDS-T are allocated for this engagement.

ENGAGEMENT CRITERIA
Observation codes: + = good; o = o.k.; - = bad (leave blank if not observed).

SEARCH
___Crew searches between and during engagements.
___Crew concentrates search in tank's primary sector.
___Crew searches 360°.
___Crew scan entire sectors/perform detailed searches.
___Crew uses binos/vision blocks.

DEGRADED MODE AND SUBSEQUENT FIRE COMMANDS
___TC gives timely fire commands.
___TC gives brief, comprehensive fire commands suitable to degraded condition.
___TC selects proper ammo.
___TC specifies battlesight when appropriate.
___TC selects and sequences targets correctly.
___TC gives accurate fire command (tgt descr., etc.).
___TC gives proper corrections, if required.
___Crew members give timely, correct verbal responses (crew duties).
___TC/gunner use standard adjustments/subs fire commands per crew/adj tank observations.
___The crew isolates/corrects/ compensates for degraded conditions ASAP.

NOTES.

ACQUISITION REPORTS
___Crew transmits timely reports.
___Crew transmits brief reports.
___Crew gives accurate target descriptions.
___Crew gives accurate target locations.

MOVEMENT
___Crew coordinates movement w/ adjacent tanks.
___Crew properly occupies/moves between positions.
___TC directs movement out of posn to avoid AT fires.
___Driver maintains a steady firing platform and suitable speed.
___Crew avoids untrafficable terrain.

CONTACT REPORTS
___Crew immediately reports contact.
___Crew accurately reports direction of contact.
___Crew accurately reports target types.
___Crew transmits brief, clear contact reports.

SPOT REPORTS
___Crew accurately reports threat data.
___Crew accurately reports location (within 200 meters).
___Crew accurately reports friendly actions.
___Crew transmits SPOT reports ASAP.

Annex 4

Sample Engagement 2: Engage Simultaneous Targets (Offense)

CONDITIONS: The tank is attacking as part of the lead section in a movement to contact. Enemy contact is probable. The platoon is in bounding overwatch. Battlecarry is HEAT/900 meters. One stationary BMP frontal target (800-1000 meters), one infantry squad (500-800 meters), and one ATGM team (dismounted, 300-600 meters) are to be presented while the tank is moving. An appropriate hull down position is within 200 meters of the tank at the time of target presentation. Two rounds HEAT-TP-T, 50 rds coax, and 50 rds Cal .50 are allocated for this engagement.

ENGAGEMENT CRITERIA
Observation codes: + = good; o = o.k.; - = bad (leave blank if not observed).

SEARCH
___Crew searches between and during engagements.
___Crew concentrates search in tank's primary sector.
___Crew searches 360°.
___Crew scan entire sectors/perform detailed searches.
___Crew uses binos/vision blocks.

NORMAL MODE FIRE COMMANDS AND REENGAGEMENT
___TC gives timely fire commands.
___TC gives brief, comprehensive fire commands.
___TC selects proper ammo.
___TC selects and sequences targets correctly.
___TC gives accurate target descriptions.
___TC gives proper corrections (if required).
___Crew members give timely, correct verbal responses (crew duties).
___Crew reengages missed targets.

SPOT REPORTS
___Crew accurately reports threat data.
___Crew accurately reports location (within 200 meters).
___Crew accurately reports friendly actions.
___Crew transmits SPOT reports ASAP.

NOTES.

ACQUISITION REPORTS
___Crew transmits timely reports.
___Crew transmits brief reports.
___Crew gives accurate target descriptions.
___Crew gives accurate target locations.

MOVEMENT
___Crew coordinates movement with adjacent tanks.
___TC selects suitable positions (pri, alt, suppl).
___Crew properly occupies/moves between positions (hide, turret, or hull down).
___TC directs movement out of position to avoid AT fires.
___Driver maintains stead firing platform and suitable speed.
___Crew avoids untrafficable terrain.

REACTION DRILLS
___Crew returns fire on contact.
___Crew turns tank/turret per tactical situation.
___Crew effectively avoids AT fires by evasive maneuvers.

CONTACT REPORTS.
___Crew immediately reports contact.
___Crew accurately reports direction of contact.
___Crew accurately reports target types.
___Crew transmits brief, clear contact reports.

Annex 5

Platoon and Platoon Leader/Platoon Sergeant BDS Practice Examples

Platoon and Platoon Leader Engagement Example 1

You are a tank platoon evaluator on a MILES exercise.

The platoon being evaluated is the lead element in a movement to contact. It had about 2 1/2 hours planning time during which it conducted a tactical road march from the assembly area to the release point, left the road, and continued moving toward the passage point in column. The passage point is in a defile causing the platoon to remain in column at least to the head of the defile.

As he came to the top of the defile, the platoon leader slowed down and stopped in turret defilade. He conducted a search of the area before proceeding. He acquired an enemy tank at 2 o'clock relative to his primary direction of movement (south) at a range of about 900 meters. He directed his driver to move out of the defile then turn right (toward the target). The tank had to move forward about 25-30 meters before it could turn toward the enemy.

The platoon leader did not give a fire command or lay the main gun for direction until the tank began turning. As he moved forward, the platoon leader gave the hand and arm signal for a wedge formation. The platoon leader attempted to engage the target (stabilized), but was shot by the enemy tank before he could get his first round off.

As the platoon leader moved out, his wingman followed. When the platoon leader signalled the wedge formation, the wingman could not react until he cleared the defile as well. He observed the platoon leader's tank turn right and the turret rotate slightly. As the wingman cleared the defile, he began swinging to the platoon leader's left to take up position in the formation. As he made his turn, he observed the enemy's muzzle flash and the resultant hit on the platoon leader's tank. The wingman immediately transmitted a contact report and attempted to engage the enemy. The wingman continued to move toward the enemy tank. The enemy tank fired on and destroyed the wingman before the wingman could return fire.

The platoon sergeant's tank was third in the column. As he came to the top of the defile, the platoon sergeant observed his leader moving to the right and signalling a wedge formation. The platoon leader's wingman was just making the turn. The platoon sergeant sensed a weapons effect to the right--at 2 o'clock, and saw the hit on the platoon leader's tank. The platoon sergeant ordered his driver to stop, issued a fire command, and laid the gun on the target. At about this point, the contact report was heard on the platoon radio network. The platoon sergeant engaged and destroyed the enemy tank about 3 seconds after the enemy shot the second tank.

The platoon sergeant turned to check the defile behind his tank. He observed his own wingman about 25 meters down the defile waiting for further instructions. The platoon sergeant signalled his wingman to back up then backed his own tank down the defile to a turret down position. The platoon sergeant made a quick search of the area then made a spot report and SITREP to the company commander.

Platoon and Platoon Leader Engagement Example 2

You are the platoon evaluator for a tank platoon negotiating an instrumented dry fire range at Ft. Hood. The tanks each mount thru-site video (TSV), and modified MILES gear that is linked to a location-tracking device, POSNAV. Targets are equipped with MILES receptors and will fall when hit. The targets are activated automatically when one or more tanks enters specified zones as determined by the POSNAV system. The system also includes a shoot-back capability that "kills" tanks within the platoon, via the POSNAV, if the platoon fails to shoot enough targets in a specified time period.

The platoon received an operations order for an offensive operation. It is the lead platoon of a tank-heavy company-team that will attack through a unit in defensive positions. The team objective is about 6 kilometers beyond the LD/LC. The platoon has been warned of several likely motor-rifle platoon defensive positions in their zone of attack. They have also been warned that the enemy will probably employ a tank-pure reserve of 6 to 8 tanks in a counterattack against any penetration or that the enemy may commit a follow-on (second echelon) force in their battalion-task force sector.

The platoon moves in column formation from the AA along the specified route. The passage lane has been coordinated, and the platoon moves through the passage lane to the release point. The friendly unit's positions are on the forward slope of a ridge line. The release point is on the rear slope just below a saddle. The platoon begins to deploy into a wedge formation as it clears the release point. As it passes through the saddle, the platoon's formation resembles a staggered column more than a wedge. That formation is suitable given the width of the saddle and the requirement to avoid running over the friendly defensive positions. Gun tube orientations are good, and 7 of the 8 exposed crew members appear to be scanning 360°.

As the platoon clears the saddle and moves down the forward slope, the wingmen move out to the flanks, and the wedge formation takes shape. It takes the platoon about 10-15 seconds to get into formation. Orientation is still good as the platoon continues to move along its specified axis.

About 300 meters beyond the friendly positions, the platoon crosses a small rise and encounters 4 enemy tanks and 9 BMPs at a range of about 700-1000 meters. The target array is across a front of about 800 meters.

RED ONE, the platoon leader, transmits the following: "RED--CONTACT WEST. FRONTAL--FIRE!" Before he completes his transmission, the platoon sergeant, RED FOUR, opens fire and kills one of the tank targets. Within 3 seconds of the initial transmission, every tank in the platoon has opened fire, and three of the tank targets have been knocked down.

Individual vehicles in the platoon have begun changing direction in an erratic manner (zig-zagging) but generally continue to move west--closing on the enemy. The platoon leader comes up on the company net with the following: "CONTACT WEST--IMMEDIATE SUPPRESSION--T-R-P FOUR-ONE[1], OVER."

The FIST acknowledges the request for immediate suppression. There is a stream bed about 400 meters short of the targets. Just beyond that are the first semi-covered positions available to the platoon. The platoon continues to move in that direction firing in stabilized mode on the enemy array. Each tank appears to be firing a round every 6 to 10 seconds. The second ragged volley from the platoon kills the fourth enemy tank and three BMPs.

The automated range system "kills" RED TWO on the platoon's right flank before the platoon reaches the covered positions. Thirty seconds into the engagement, the remaining target array is suddenly halved by the notional fires of a sister tank platoon. Firing from hull down positions at ranges of 200-500 meters, the platoon completes the destruction of the enemy force about 35 to 40 seconds into the engagement.

RED ONE sends the following on the company net: "BLACK SIX, THIS IS RED ONE. SPOT REPORT. OVER."

BLACK SIX responds: "SEND IT. OVER."

"ENGAGED FOUR T-80 TANKS, NINE BMPS, GRID 265454. ENEMY DESTROYED. KILO ONE CHARLIE PAPA ONE WEST TWO[2], CONTINUING MOVE TO CHARLIE PAPA TWO. OVER."

"BLACK SIX, ROGER. BLUE ONE, COVER RED'S MOVE. OVER."

"THIS IS BLUE ONE. WILCO, SET. OUT."

RED ONE switches to the platoon net and directs: "RED, THIS IS RED ONE. MOVE. OUT." As he finishes his transmission, the platoon leader backs out of his firing position and begins moving up the slope to his front. Suddenly, the FIST comes up on the company net and warns: "SPLASH ON T-R-P FOUR ONE IN FIFTEEN SECONDS! OVER."

[1]TRP 41 is a preplanned target on the ridge line to the platoon's front. It corresponds directly to part of the enemy array such that a standard sheaf will effectively suppress about two-thirds of the array. CP 2 is slightly to the south of the TRP along the same ridge line.

[2]Assume that the unit SOP indicates that friendly vehicle losses are reported as follows: KILO (for "killed") followed by the number of tanks lost, the direction from any graphic control measure, and the distance from the reference point in increments of 100 meters. In this case, one tank was lost 200 meters west of checkpoint one.

Immediately, the platoon leader comes up on the platoon net: "INCOMING! BUTTON UP AND STOP!" RED ONE slams to a halt, and the hatches are closed within about 3 seconds. RED THREE and FOUR stop and take a little longer to button up.

RED ONE switches to the company net again: "SPLASH, OUT--CHECK FIRE. OVER." The FIST responds "CHECK FIRE. OUT." A few seconds later, the platoon observes some HOFFMAN charges to its right front simulating the incoming artillery.

The platoon leader waits a few more seconds then begins moving up the slope. The platoon slows down and stops in turret down positions near the ridge line. There is about 80-100 meters between tanks and plenty of room to maneuver, if necessary. The tanks are obviously searching the terrain to their front. The TCs and loaders have opened their hatches and are scanning 360°.

Once in position, RED ONE comes up on the company net: "BLACK SIX, THIS IS RED ONE. SET, CHARLIE PAPA TWO, NEGATIVE CONTACT. OVER." When BLACK SIX acknowledges, the first engagement is considered complete.

Sample Platoon Engagement 1. Movement to Contact v. Threat Withdrawal.

CONDITIONS. The platoon is attacking as the lead element in a company-team movement to contact. As the platoon crosses the LD/LC, it encounters one enemy tank at 700-1000 meters representing an element in the threat security zone. The threat tank engages, reports, and withdraws.

EVALUATION CRITERIA: Pldr/PSG.
Observation codes: + = good; o = o.k.; - = bad (leave blank if not observed).

FIRE COMMANDS
___Issues clear, brief fire commands.
___Uses suitable fire pattern/ technique.
___Issues effective fire commands.

REQUEST INDIRECT FIRES
___Makes clear, brief, accurate calls for fire.
___Uses FA/Mort to suppress or to reinforce direct fires.
___Uses indirect smoke effectively.
___Coordinates FA/Mort with plt movement & fires.

FRAGMENTARY ORDERS
___Uses only when req'd to refine/ modify plan.
___Conforms with commander's intent.
___Issues clear/brief/timely FRAGOs.

SUPERVISION
___Monitors/corrects subordinates during execution.
___Issues clear, brief, specific correctives.
___Uses situational leadership.

NOTES.

Sample Platoon Engagement 1. Movement to Contact v. Threat Withdrawal.

EVALUATION CRITERIA: Platoon.
Observation codes: + = good; o = o.k.; - = bad (leave blank if not observed).

ROUTE SELECTION
___Uses appropriate route.
___Uses cover & concealment.
___Uses reduced visibility.
___Avoids untrafficable terrain.

ORIENTATION (OFFENSE)
___Orients on primary threat.
___Tanks orient per formation.
___Maintains internal/external mutual support.
___Provides continuous overwatch.
___Shifts orientation per moving element.
___Returns fire immediately on contact.
___Reports contact immediately.
___Executes appropriate drills immediately on contact.

DIRECT FIRES
___Distributes fires effectively.
___Engages per target classifications.
___Engages per target range.
___Uses suitable volume of fires.
___Shifts/ceases fires when suitable.

MOVEMENT
___Uses suitable mvt tech & formation
___Maintains stable formation.
___Adjusts formation to terrain.
___Uses suitable movement rate.
___Bounds don't out-distance overwatch.
___Changes direction/formation quickly.

COMMUNICATION
___Crews use proper RTP.
___NCS maintains net discipline.
___Crews transmit clear, brief msgs.
___Uses COMSEC eqpt.
___Uses visual commo.
___Crews transmit timely, accurate messages.

NOTES.

Annex 7

Sample Platoon Engagement 2. Movement to Contact v. Threat Meeting Engagment.

CONDITIONS. The platoon is attacking as the lead element in a company-team movement to contact. Shortly after the platoon crosses the LD/LC, it encounters a threat motorized rifle company with tanks representing the forward security detachment of a threat advance guard battalion.

EVALUATION CRITERIA: Pldr/PSG.
Observation codes: + = good; o = o.k.; - = bad (leave blank if not observed).

FIRE COMMANDS
___Issues clear, brief fire commands.
___Uses suitable fire pattern/ technique.
___Issues effective fire commands.

REQUEST INDIRECT FIRES
___Makes clear, brief, accurate calls for fire.
___Uses FA/Mort to suppress or to reinforce direct fires.
___Uses indirect smoke effectively.
___Coordinates FA/Mort with plt movement & fires.

FRAGMENTARY ORDERS
___Uses only when req'd to refine/ modify plan.
___Conforms with commander's intent.
___Issues clear/brief/timely FRAGOs.

SUPERVISION
___Monitors/corrects subordinates during execution.
___Issues clear, brief, specific correctives.
___Uses situational leadership.

NOTES.

Sample Platoon Engagement 2. Movement to Contact v. Threat Meeting Engagment.

EVALUATION CRITERIA: Platoon.
Observation codes: + = good; o = o.k.; - = bad (leave blank if not observed).

ROUTE SELECTION
___Uses appropriate route.
___Uses cover & concealment.
___Uses reduced visibility.
___Avoids untrafficable terrain.

ORIENTATION (OFFENSE)
___Orients on primary threat.
___Tanks orient per formation.
___Maintains internal/external mutual support.
___Provides continuous overwatch.
___Shifts orientation per moving element.
___Returns fire immediately on contact.
___Reports contact immediately.
___Executes appropriate drills immediately on contact.

DIRECT FIRES
___Distributes fires effectively.
___Engages per target classifications.
___Engages per target range.
___Uses suitable volume of fires.
___Shifts/ceases fires when suitable.

MOVEMENT
___Uses suitable mvt tech & formation
___Maintains stable formation.
___Adjusts formation to terrain.
___Uses suitable movement rate.
___Bounds don't out-distance overwatch.
___Changes direction/formation quickly.

COMMUNICATION
___Crews use proper RTP.
___NCS maintains net discipline.
___Crews transmit clear, brief msgs.
___Uses COMSEC eqpt.
___Uses visual commo.
___Crews transmit timely, accurate messages.

NOTES.

Appendix D

Standard Setting Workshop Procedures

CONTENTS

In the workshop instructions, unmodified text is to be read by the workshop leader. **Highlighted text relates action the workshop leader should take.** Text in small print is a replication of information on the hand-outs given to workshop participants.

Workshop Instructions

Project Overview and Workshop Purpose

We are working on a project to develop threat-based tests of tank gunnery at the crew and platoon level for use in training research projects. As with any test, decisions must be made regarding how the test is to be scored. All of you are familiar with the Table VIII and Table XII scoring process. For Table VIII, crews are scored on the speed and accuracy of targets hit. Any procedural errors or crew duties penalty points are subtracted from the speed and accuracy score to yield an overall score. For Table XII, platoons are scored on the number of targets hit within a certain time limit. The evaluator scores tactics and procedures by using a checklist, and platoons receive a separate gunnery and tactical proficiency score.

We are not attempting to replace Table VIII or Table XII testing. We're interested in augmenting Table VIII and XII data with data from some new exercises developed for research purposes. Our research tests may be administered under instrumented dry fire or MILES testing conditions or live fire conditions. We are interested in the same kinds of scores obtained in Tables VIII and XII, that is, speed and accuracy of target hits, number of targets hit, and tactics and procedures. But we're interested in obtaining those scores in a different way. Specifically, in scoring tactics and procedures, we'll use a rating scale instead of a checklist. The rating scale approach offers a simple solution to capturing performance at a fairly general level.

Currently, evaluators assess tactics and procedures for each engagement. For our research tests, we propose that evaluators use rating scales to rate a crew, platoon, or platoon leader's tactics and procedures for a group of engagements within an exercise or for an entire exercise.

The evaluation criteria that you will set standards on today were identified after a thorough review of current U.S. Army publications of tank gunnery tactical and technical doctrine. After initial development, armor experts like yourselves reviewed the criteria. Their suggested revisions and modifications appear in the rating scales you'll see today. The goal of today's workshop is to establish performance standards for each criterion.

You are here because you are experts in tank gunnery. We need your assistance and expertise in setting standards on these rating scales. We will start with the crew scales and then work with the platoon scales followed by the platoon leader scales. Are there any questions before we begin?

Background Information and Privacy Act Statement

First, I'd like for each of you to complete a Background Information Form. Please write as neatly and clearly as possible. [Distribute pencils and the Background Information form.]

As for any data collection activity, I must read to you the Privacy Act Statement.

This is a personnel research data collection activity sponsored by the US Army Research Institute for the Behavioral and Social Sciences pursuant to its research mission as described in AR 70-1. When identifiers, name or social security number, are requested, they are to be used for administrative and statistical control purposes only. Full confidentiality will be maintained during the processing of these data.

Do you have any questions about the Privacy Act Statement?

[Walk through the Background Information form as the SMEs complete it. Remind them of the last name, first name, and middle initial format for their names. Tell them today's date in the Day Month Year format (e.g., 20 February 1990). Encourage them not to leave any blanks. For example, if they have been in the army for 10 years and 0 months, ask them to write "0" for the number of months. If any question is not applicable, ask them to write "NA" or to put a dash in the blank. Collect the forms when the SMEs are finished. At some point in the workshop, check to see that no information is missing.]

Crew Standard Setting

Performance levels. The first thing I'd like for you to do is to think of four levels of crew tactical and procedural performance with the following labels and definitions. [Distribute Hand-Out 1 and the Crew - Initial Standard Setting Phase form.] As you read through these definitions, try to think of crews you've seen, been a part of, etc. in the past that fit these definitions.

- **Distinguished.** A distinguished crew is among the best in the army. A crew operating at this level makes almost no tactical and procedural errors. They effectively employ SOP.
- **Superior.** A superior crew may make a few tactical and procedural errors, but their errors are not likely to endanger themselves or other crews. They effectively employ SOP.
- **Qualified.** A qualified crew makes some tactical and procedural errors which may endanger themselves and/or other crews, but for the most part their performance is acceptable. They generally employ effective SOP.
- **Unqualified.** An unqualified crew is among the worst in the army. These crews make so many tactical and procedural errors that they endanger themselves and other crews. Their use of SOP is ineffective.

Do you have any questions about the performance levels? Can you recall crews that fit each of these definitions? [Expect the SMEs to feel that the definitions should be modified. Work with them to come up with a definition that is acceptable to the group.]

Initial phase. Next, consider a rating scale of 1 to 5 where 1 indicates poor performance and 5 indicates excellent performance. [Point to the rating scale on Hand-Out 1 - Page 1.]

1	2	3	4	5
poor performance				excellent performance

This is the rating scale you'll use to indicate performance level cutoffs.

Take a look at the example on Page 2 of Hand-Out 1. The evaluation criterion or rating scale title appears at the top of the page. Beneath the criterion title is a brief summary of the behaviors covered by the criterion. Beneath the summary are facet scales. We want you to first set standards for each facet then for each evaluation criterion. You'll use a three step process to do this.

The first step is to set three cutoff ratings for each facet. Be sure to look at the evaluation criterion title, read the summary, and read each facet before indicating your cutoff ratings. Working with one facet at a time, indicate the **lowest** rating a crew could receive on that facet to be considered distinguished. Next indicate the **lowest** rating a crew could receive to be considered superior and then the **lowest** rating to be considered qualified. You do not need to worry about setting a cutoff rating for unqualified crews. Indicate your rating cutoffs by circling the appropriate number on the scale beside the facet.

For example, the first evaluation criterion is Search Procedure, and the first facet is "Crew members search between and during engagements as crew duties permit." Using the 1 to 5 scale, you decide that a 5 is the lowest rating a crew can receive to be considered distinguished on the first facet. You feel that a 3 is the lowest rating a crew can receive to be considered superior and a 2 is the lowest to be considered qualified. You would circle these values on the scale beside the first facet for the Search Procedure rating scale as shown in the example. As you circle your cutoff ratings, label them D for distinguished, S for superior, and Q for qualified.

Crew

Search Procedure

The crew searches in assigned sectors between engagements. Search activities are concentrated in the tank's primary sector but also includes 360° coverage commensurate with the tactical situation. Each crewman scans his entire sector and performs detailed searches of possible danger areas. Binoculars and night vision goggles are used to supplement the search during open-hatch operations. Vision blocks or night vision periscopes are used during closed hatch operations. Selected crew members continue searching during engagements as the situation permits. Standard sectors for each crew member are:

TC: Left limit of the tank's primary sector to the tank's direct rear (i.e., 11 o'clock to 6 o'clock, with 12 o'clock being to the direct front of the tank, or center of the primary sector).
GUNNER: Left limit to right limit of the tank's primary sector (i.e., 11 o'clock to 1 o'clock).
LOADER: Tank's direct rear to right limit of the tank's primary sector (i.e., 6 o'clock to 1 o'clock).
DRIVER: Left front fender to right front fender of the tank when the view is not masked by terrain.

Individual sectors may be situationally adjusted, particularly according to the mutual support provided by other tanks within the section/platoon. However, the basic principles of all-round security, concentration on the primary sector, and equitable division of labor will not be compromised.

Rating Scales

	Never	Rarely	Often	Usually	Always
Crew members search between and during engagements as crew duties permit.	1	2 Q	3 S	4	5 D
Crew members concentrate searches in the tank's primary sector.	1	2 Q	3 S	4	5 D
The crew provides 360° security according to the tactical situation.	1	2 Q	3	4 S	5 D
Crewmen scan their entire sectors and perform detailed searches of danger areas.	1	2	3 Q	4 S	5 D
Crewmen use binoculars or night vision goggles - open hatch and vision blocks or night vision periscopes - closed hatch.	1	2 Q	3 S	4	5 D

Total: Qualified 11 Superior 17 Distinguished 25

5 6 7 8 9 10 11 Q 12 13 14 15 16 17 S 18 19 20 D 21 22 23 24 25

After setting cutoff ratings for each facet, we'd like for you to sum your cutoff ratings across facets for distinguished, superior, and qualified performance. In the example, the rater finished setting cutoff ratings for each facet of the Search Procedure rating scale. Then he summed his cutoff ratings for each of the three levels of performance. His cutoff ratings for distinguished performance summed to 25, cutoffs for superior summed to 17, and those for qualified summed to 11. He placed those values in the appropriate blanks beneath the facet scales.

The sum across facets of distinguished, superior, and qualified cutoffs indicates your cutoff ratings for that evaluation criterion. After looking at the the sum of your cutoff ratings, you may feel that the summed cutoffs are too strict. In the example, the rater's summed cutoff ratings for distinguished performance was 25. To obtain that rating, a crew would have to get a rating of "5" on all the facets. You may decide that a perfect rating of "5" on all 5 facets is too strict. You may feel that for Search Procedures

a total rating of 20 across all the facet scales is sufficient for distinguished performance. The third step allows you to account for this discrepancy.

The row of numbers at the bottom of each page range from the lowest possible rating to the highest possible rating a crew could receive on that evaluation criterion if you sum all the facet ratings for that particular criterion. If a crew received a rating of "1" for all the Search Procedure facets, the facet ratings would sum to 5 because there are 5 facets for Search Procedure. If a crew received a rating of "5" for all Search Procedure facets, the facet ratings would sum to 25. Thus, possible summed facet ratings for Search Procedure range from 5 to 25.

If you feel that the sum across facets of your distinguished, superior, and qualified cutoff ratings is not quite right, you can "correct" that by circling the appropriate number in the row of numbers at the bottom of the page. You would circle the number in the row at the bottom of the page that you feel is the **lowest** summed rating across facets a crew could receive to be considered distinguished. After circling that number, you would label it D for distinguished as has been done in the example. Next you would circle the **lowest** summed rating a crew could receive to be considered superior and label it S. Then circle the **lowest** summed rating to be considered qualified, and label it Q.

If you are satisfied with the values obtained in step two, please circle those values and label them D, S, and Q as appropriate. In other words, if your cutoff ratings across facets for distinguished performance sums to 20 and you feel comfortable with that, circle the number 20 in the row at the bottom of the page and label it D.

You may disagree with the cutoff ratings used in the example. That's fine; it's just an example. The important thing is that you understand the procedure. Do you have any questions? Please write as clearly and neatly as possible. You may begin. [As participants complete the initial standard setting phase, give them a short break. Use this time to tally the participants' responses.]

<u>Iterative process</u>. In the next phase of the standard setting process, I'd like to discuss the rationale for some of the cutoff ratings you just made. To save time, we'll discuss only the cutoff ratings for each evlauation criterion. That is, we'll discuss the cutoffs you set in the last step when you circled cutoffs in the row of numbers at the bottom of the page. Let's look at rating scale ______________ [the rating scale and performance definition combination in which the cutoff ratings were most discrepant]. The cutoff ratings for ______________ [the performance level: distinguished, superior, qualified] ranged from _____ to _____. Who suggested a cutoff rating of _____ [the lowest rating]? What was your rationale for selecting that cutoff rating? [Encourage the participant to state his rationale, but don't let him expound on it. Write down his comments.] Who suggested a cutoff rating of _____ [the highest rating]? [Again, encourage the participant to state his rationale, but don't let him expound on it. Note his comments, too. Once the opposing views have been aired, there is sometimes a tendency for participants to "over defend" their views, and an argument may ensue. One person may try to monopolize the discussion and impose his views on the other participants. Don't let this happen! If one person seems to be

dominating the discussion, politely cut him off. Either ask someone else his opinion or summarize the discussion and move to another performance discriminator. Sometimes the discussion will "bog down." This occurs when two or more dominant individuals keep restating their views. If this happens, end the discussion. Help the group come to a convergent decision. In other words, a decision should be reached that is generally acceptable to the group, but it doesn't have to be unanimous. When a decision has been made, summarize it for the group, and write it down.]

[When a convergent decision has been made on the most discrepant rating scale and performance definition combination, begin discussions on the second most discrepant combination. Follow the same procedures described above. Take notes, and remember not to allow one person to dominate the discussion. Discuss as many discrepant combinations as time will allow. When the discussion ends, collect the Crew - Initial Standard Setting Phase form.]

Final phase. After discussing the rationale behind some of your ratings, I'd like for you to complete the final step of the rating process again. [Distribute the Crew - Final Standard Setting Phase form.] Circle and label the lowest summed facet rating a crew can receive to be considered distinguished, superior, and qualified for each evaluation criterion. Write as clearly as possible. Are there any questions? You may begin. [Collect the Crew - Final Standard Setting Phase form when everyone has finished.]

Platoon Standard Setting

Performance levels. After setting standards for crew performance, you are familiar with the procedures we'll be using to set platoon performance standards. [Distribute Hand-Out 3 and the Platoon - Initial Standard Setting Phase form.] While the performance levels remain the same, the performance definitions have been altered to reflect platoon rather than crew performance. Take a few minutes to read through these definitions.

- **Distinguished.** A distinguished platoon is among the best in the army. A platoon operating at this level makes almost no tactical and procedural errors. It is very well coordinated (i.e., battle drills appear well practiced) and effectively employs SOP.
- **Superior.** A superior platoon may make a few tactical and procedural errors, but their errors are not likely to endanger themselves or other platoons. It is generally well coordinated (i.e., battle drills appear fairly well practiced) and effectively employs SOP.
- **Qualified.** A qualified platoon makes some tactical and procedural errors which may endanger themselves and/or other platoons, but for the most part their performance is acceptable. It iscoordinated, but battle drills could use more practice. It generally employs effective SOP.
- **Unqualified.** An unqualified platoon is among the worst in the army. These platoons make so many tactical and procedural errors that they endanger themselves and other platoons. It is completely uncoordinated and appears confused. Its use of SOP is ineffective.

Do you have any questions about the performance levels? Can you recall platoons that fit each of these definitions? [If the SMEs feel that the definitions should be modified (they probably will), work with them to come up with a definition that is acceptable to the group.]

Initial phase. Recall the rating scale you used to set standards for crew evaluation criteria where 1 indicates poor performance and 5 indicates excellent performance. Using that same scale, indicate the performance level cutoff for each facet of each platoon evaluation criterion. For each facet, first indicate the **lowest** rating a platoon could receive to be considered distinguished. Next indicate the **lowest** rating a platoon could receive to be considered superior and then the **lowest** rating to be considered qualified. Once again, indicate your rating cutoffs by circling and labeling the appropriate numbers on the scale beside the facet.

Then sum across facets your cutoff ratings for distinguished, superior, and qualified cutoffs. After studying your summed cutoff ratings, circle and label the numbers in the row at the bottom of the page that you feel is the **lowest** summed rating across facets a platoon could receive to be considered distinguished, superior, and qualified. Remember that if you are satisfied with the summed facet ratings, please circle those values and label them D, S, and Q as appropriate.

Do you have any questions? Again, please write as clearly and neatly as possible. You may begin. **[As participants complete the initial standard setting phase, give them a short break. Use this time to tally the participants' responses.]**

Iterative process. Now I'd like to discuss the rationale for some of the ratings you just made. **[Follow the same process described above for the crew iterative process. Be aware that when opposing views have been aired there is sometimes a tendency for participants to "over defend" their views and an argument may ensue. Don't let one person monopolize the discussion! If that happens, cut the person off by either asking someone else his opinion or summarize the discussion and move to another performance discriminator. If the discussion "bogs down," end the discussion. The decision reached doesn't have to be unanimous, but it should be generally acceptable to the group. When a decision has been made, summarize it for the group, and write it down.]**

[When a convergent decision has been made on the most discrepant evaluation criteria and performance definition combination, begin discussions on the second most discrepant combination. Follow the same procedures described above. Take notes, and remember not to allow one person to dominate the discussion. Discuss as many discrepant combinations as time will allow. Collect the Platoon - Initial Standard Setting Phase form when the discussion is finished.]

Final phase. After discussing the rationale behind some of your ratings, I'd like for you to complete the rating process again. **[Distribute the Platoon - Final Standard Setting Phase form.]** Use the same procedure and the same scale you used before, and write as clearly as possible. Are there any questions? You may begin. **[Collect the completed Platoon - Final Standard Setting Phase forms.]**

Platoon Leader/Platoon Sergeant Standard Setting

Performance levels. After setting standards for both crew and platoon performance, you know the procedures we'll be using to set platoon leader/platoon sergeant performance standards. [Distribute Hand-Out 4 and the Platoon Leader/Platoon Sergeant - Initial Standard Setting Phase form.] Once again, the performance levels remain the same, however the performance definitions have been altered to reflect platoon leader/platoon sergeant performance.

- **Distinguished.** A distinguished platoon leader/platoon sergeant is among the best in the army. A platoon leader/platoon sergeant operating at this level makes almost no tactical and procedural errors.
- **Superior.** A superior platoon leader/platoon sergeant may make a few tactical and procedural errors, but his errors are not likely to endanger himself or his platoon.
- **Qualified.** A qualified platoon leader/platoon sergeant makes some tactical and procedural errors which may endanger himself and/or his platoon, but for the most part his performance is acceptable.
- **Unqualified.** An unqualified platoon leader/platoon sergeant is among the worst in the army. These platoon leaders/platoon sergeants make so many tactical and procedural errors that they endanger themselves and their platoons.

Do you have any questions about the performance levels? Can you recall platoon leaders/platoon sergeants that fit each of these definitions? [Expect the SMEs to feel that the definitions should be modified. Work with them to come up with a definition that is acceptable to the group.]

Initial phase. Using the same 1 equals poor performance to 5 equals excellent performance scale, indicate the performance level cutoff for each facet for platoon leader/platoon sergeant evaluation criterion. Once again for each facet, indicate the **lowest** rating a platoon leader/platoon sergeant could receive to be considered distinguished. Next indicate the **lowest** rating a platoon leader/platoon sergeant could receive to be considered superior and then the **lowest** rating to be considered qualified. Again, indicate your rating cutoffs by circling and labeling the appropriate numbers on the scale beside the facet.

Then sum your cutoff ratings across facets for distinguished, superior, and qualified cutoffs. After studying your summed cutoff ratings, circle and label the numbers in the row at the bottom of the page that you feel are the **lowest** summed ratings across facets a platoon leader/platoon sergeant could receive to be considered distinguished, superior, and qualified. Remember that if you are satisfied with the summed facet ratings, please circle those values and label them D, S, and Q as appropriate.

Do you have any questions? Again, please write as clearly and neatly as possible. You may begin. [As participants complete the initial standard setting phase, give them a short break. Use this time to tally the participants' responses.]

Iterative process. Again, let's discuss the rationale for some of the ratings you just made. [Follow the same process described above for the crew and platoon iterative process. Remember not to let one person monopolize the discussion and that the decision doesn't have to be unanimous, but it should be generally acceptable to the group. When a decision has been made, summarize it for the group, and write it down.]

[When a convergent decision has been made on the most discrepant evaluation criteria and performance definition combination, begin discussions on the second most discrepant combination. Follow the same procedures described above. Take notes, and remember not to allow one person to dominate the discussion. Discuss as many discrepant combinations as time will allow. Don't forget to collect the Platoon Leader/Platoon Sergeant - Initial Standard Setting Phase forms after the discussion.]

Final phase. After discussing the rationale behind some of your ratings, I'd like for you to complete the rating process again. [Distribute the Platoon Leader/Platoon Sergeant - Final Standard Setting Phase form.] Use the same procedure and the same scale you used before, and write as clearly as possible. Are there any questions? You may begin. [Make sure you collect all forms and pencils before everyone leaves.]

Thank you for your time and assistance. We really appreciate your efforts and will use your input.

Annex 1

BACKGROUND INFORMATION

Name:____
Last Name, First Name Middle Initial

SSN:______________________________________

Today's Date:______________________________
Day Month Year

Current Pay Grade:_________________________
(e.g., E-6, E-7, etc.)

Time in Army:______________________________
Years Months

M1 Experience:_______________________________
Years Months

Have you ever served as a Table VIII evaluator? (circle one) YES NO

If yes, how many times?____

When was the last time you served as an evaluator?_______________
Month Year

Have you ever served as a Table XII evaluator? (circle one) YES NO

If yes, how many times?____

When was the last time you served as an evaluator?_______________
Month Year

<u>Privacy Act Statement</u>

This is a personnel research data collection activity sponsored by the U.S. Army Research Institute for the Behavioral and Social Sciences pursuant to its research mission as described in AR 70-1. When identifiers, name or social security number, are requested, they are to be used for administrative and statistical control purposes only. Full confidentiality will be maintained during the processing of these data.

Annex 2

Crew Standard Setting Hand-Outs and Response Sheets

Crew Performance Levels

- **Distinguished.** A distinguished crew is among the best in the army. A crew operating at this level makes almost no tactical and procedural errors. They effectively employ SOP.
- **Superior.** A superior crew may make a few tactical and procedural errors, but their errors are not likely to endanger themselves or other crews. They effectively employ SOP.
- **Qualified.** A qualified crew makes some tactical and procedural errors which may endanger themselves and/or other crews, but for the most part their performance is acceptable. They generally employ effective SOP.
- **Unqualified.** An unqualified crew is among the worst in the army. These crews make so many tactical and procedural errors that they endanger themselves and other crews. Their use of SOP is ineffective.

Rating Scale

1	2	3	4	5
poor performance				excellent performance

Hand-Out 1 - Page 1

Example

The first evaluation criterion is Search Procedure, and the first facet is "Crew members search between and during engagements as crew duties permit." Using the 1 to 5 scale, you decide that for that facet a 5 is the lowest rating a crew can receive to be considered distinguished. You feel that a 3 is the lowest rating a crew can receive to be considered superior and a 2 is the lowest to be considered qualified. You would circle these values on the scale beside the first facet as shown in the example. As you circle your cutoff ratings, label them D for distinguished, S for superior, and Q for qualified.

Next, sum your cutoff ratings across facets for distinguished, superior, and qualified performance. In the example, the rater's cutoff ratings for each facet performance summed to 25 for distinguished performance, 17 for superior, and 11 for qualified. He placed those values in the appropriate blanks beneath the facet scales.

The row of numbers at the bottom of each page range from the lowest possible rating to the highest possible rating a crew could receive on that evaluation criterion if you sum all the facet ratings for that particular criterion. You can "correct" the sum of distinguished, superior, and qualified cutoff ratings by circling the appropriate number in the row of numbers at the bottom of the page. Circle the number in the row at the bottom of the page that you feel is the **lowest** summed rating across facets a crew could receive to be considered distinguished and label it D. Next you would circle the **lowest** summed rating a crew could receive to be considered superior and label it S. Then circle the **lowest** summed rating to be considered qualified, and label it Q.

Crew SEARCH PROCEDURE

The crew searches in assigned sectors between engagements. Search activities are concentrated in the tank's primary sector but also includes 360° coverage commensurate with the tactical situation. Each crewman scans his entire sector and performs detailed searches of possible danger areas. Binoculars and night vision goggles are used to supplement the search during open-hatch operations. Vision blocks or night vision periscopes are used during closed hatch operations. Selected crew members continue searching during engagements as the situation permits. Standard sectors for each crew member are:

TC: Left limit of the tank's primary sector to the tank's direct rear (i.e., 11 o'clock to 6 o'clock, with 12 o'clock being to the direct front of the tank, or center of the primary sector).

GUNNER: Left limit to right limit of the tank's primary sector (i.e., 11 o'clock to 1 o'clock).

LOADER: Tank's direct rear to right limit of the tank's primary sector (i.e., 6 o'clock to 1 o'clock).

DRIVER: Left front fender to right front fender of the tank when the view is not masked by terrain.

Individual sectors may be situationally adjusted, particularly according to the mutual support provided by other tanks within the section/platoon. However, the basic principles of all-round security, concentration on the primary sector, and equitable division of labor will not be compromised.

Rating Scales

	Never	Rarely	Often	Usually	Always
Crew members search between and during engagements as crew duties permit.	1	2 Q	3 S	4	5 D
Crew members concentrate searches in the tank's primary sector.	1	2 Q	3 S	4	5 D
The crew provides 360° security according to the tactical situation.	1	2 Q	3	4 S	5 D
Crewmen scan their entire sectors and perform detailed searches of danger areas.	1	2	3 Q	4 S	5 D
Crewmen use binoculars or night vision goggles - open hatch and vision blocks or night vision periscopes - closed hatch.	1	2 Q	3 S	4	5 D

Total: Qualified 11 Superior 17 Distinguished 25

5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

Hand-Out 1 - Page 3

Crew - Initial Standard Setting Phase

SEARCH PROCEDURE

The crew searches in assigned sectors between engagements. Search activities are concentrated in the tank's primary sector but also includes 360° coverage commensurate with the tactical situation. Each crewman scans his entire sector and performs detailed searches of possible danger areas. Binoculars and night vision goggles are used to supplement the search during open-hatch operations. Vision blocks or night vision periscopes are used during closed hatch operations. Selected crew members continue searching during engagements as the situation permits. Standard sectors for each crew member are:

TC: Left limit of the tank's primary sector to the tank's direct rear (i.e., 11 o'clock to 6 o'clock, with 12 o'clock being to the direct front of the tank, or center of the primary sector).

GUNNER: Left limit to right limit of the tank's primary sector (i.e., 11 o'clock to 1 o'clock).

LOADER: Tank's direct rear to right limit of the tank's primary sector (i.e., 6 o'clock to 1 o'clock).

DRIVER: Left front fender to right front fender of the tank when the view is not masked by terrain.

Individual sectors may be situationally adjusted, particularly according to the mutual support provided by other tanks within the section/platoon. However, the basic principles of all-round security, concentration on the primary sector, and equitable division of labor will not be compromised.

Rating Scales

	Never	Rarely	Often	Usually	Always
Crew members search between and during engagements as crew duties permit.	1	2	3	4	5
Crew members concentrate searches in the tank's primary sector.	1	2	3	4	5
The crew provides 360° security according to the tactical situation.	1	2	3	4	5
Crewmen scan their entire sectors and perform detailed searches of danger areas.	1	2	3	4	5
Crewmen use binoculars or night vision goggles - open hatch and vision blocks or night vision periscopes - closed hatch.	1	2	3	4	5

Total: Qualified _____ Superior _____ Distinguished _____

5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

Crew - Initial Standard Setting Phase

ACQUISITION REPORTS

Crew members use acquisition reports to alert the TC and gunner to the presence of a threat, the nature of that threat, and its specific location. Reports are timely, brief, comprehensive, and as accurate as practical under the situation. Target signatures are reported if targets cannot be positively identified.

Rating Scales

	Never	Rarely	Often	Usually	Always
Crew members transmit timely reports.	1	2	3	4	5
Crew members transmit brief reports.	1	2	3	4	5
Crew members give accurate target descriptions.	1	2	3	4	5
Crew members give accurate target locations.	1	2	3	4	5

Total: Qualified _____ Superior _____ Distinguished _____

4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

Crew - Initial Standard Setting Phase

NORMAL MODE FIRE COMMANDS AND REENGAGEMENT

Normal mode fire commands are used when the tank is fully operational. Normal fire commands are timely, brief, comprehensive and accurate. The correct ammunition is selected to engage each target according to the tactical situation. Targets are engaged in order of relative threat and according to existing section/platoon fire patterns and techniques. Corrections are used when required. Abbreviated fire commands are used when appropriate. Crew duties (e.g., announcing "UP" and "IDENTIFIED") are performed as required. Targets are reengaged if the first round misses.

Rating Scales

	Never	Rarely	Often	Usually	Always
The TC gives timely fire commands.	1	2	3	4	5
The TC gives brief, comprehensive fire commands (including abbreviated fire commands, if used).	1	2	3	4	5
The TC selects ammunition appropriate to the target and tactical situation.	1	2	3	4	5
The TC selects and sequences targets (multiple target engagements) per target classifications and section/ platoon fire patterns/techniques.	1	2	3	4	5
The TC gives accurate fire commands (target descriptions).	1	2	3	4	5
The TC gives proper corrections in fire commands (as required).	1	2	3	4	5
Crew members give timely, correct verbal responses (i.e., crew duties).	1	2	3	4	5
The crew reengages targets after first round misses.	1	2	3	4	5

Total: Qualified ______ Superior ______ Distinguished ______

8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27

28 29 30 31 32 33 34 35 36 37 38 39 40

Crew - Initial Standard Setting Phase

DEGRADED MODE AND SUBSEQUENT FIRE COMMANDS

The TC modifies the fire command according to known or suspected fire control degradations. Fire commands are timely, brief, comprehensive, and accurate. The TC selects ammunition appropriate to the target and tactical situation. The crew engages targets according to target classification and existing section/platoon fire patterns and techniques. The TC issues the direction element of the fire command when required. The TC estimates the range or asks an adjacent tank for range information when needed and takes appropriate action (e.g., specifies battlesight or indexes the range). The TC announces corrections when required. Crew duties are performed as required. The gunner/TC uses standard adjustments or subsequent fire commands based on crew/adjacent tank observations (sensings) when first round misses occur. If a degraded condition is discovered during an engagement, the crew takes appropriate immediate action to resolve the engagement then isolates and compensates for the fault at the earliest opportunity.

Crew - Initial Standard Setting Phase

DEGRADED MODE AND SUBSEQUENT FIRE COMMANDS

Rating Scales

	Never	Rarely	Often	Usually	Always
The TC gives timely fire commands.	1	2	3	4	5
The TC gives brief, comprehensive fire commands appropriate to degraded mode conditions.	1	2	3	4	5
The TC selects ammunition appropriate to the target and tactical situation.	1	2	3	4	5
The TC specifies battlesight when appropriate.	1	2	3	4	5
The TC selects and sequences targets per target classifications and section/platoon fire patterns/ techniques.	1	2	3	4	5
The TC gives brief, effective direction elements when required.	1	2	3	4	5
The TC gives accurate fire commands (target description, direction, range).	1	2	3	4	5
The TC gives proper corrections in fire commands as required.	1	2	3	4	5
Crew members give timely, correct verbal responses (i.e., crew duties).	1	2	3	4	5
The TC/gunner uses standard adjustments/ subsequent fire commands per crew/ adjacent tank observations.	1	2	3	4	5
The crew isolates, corrects, compensates for degraded conditions ASAP.	1	2	3	4	5

Total: Qualified ______ Superior ______ Distinguished ______

11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50

51 52 53 54 55

Crew - Initial Standard Setting Phase

MOVEMENT

The crew moves along available covered and concealed routes* and takes advantage of the tank's speed and available obscurants (e.g., weather, smoke) when crossing danger areas. The crew maintains formation (pace and interval) with the platoon/section. The TC selects primary, alternate, and supplemental positions appropriate to the tactical situation. The crew properly occupies and moves between hide, turret down, and hull down positions per the tactical situation. The TC controls movement into hull down positions to prevent premature exposure in coordination with his section leader or wingman per the section/platoon firing technique. The TC directs movement out of the firing position to avoid effective anti-tank fires and to minimize exposure between engagements. The driver maintains a steady firing platform (smooth acceleration, braking, turning) during engagements. The crew avoids untrafficable terrain.

* The evaluation criteria may be modified to the extent that movement is limited to established routes and firing positions on some training facilities.

Crew - Initial Standard Setting Phase

MOVEMENT

Rating Scales

	Never	Rarely	Often	Usually	Always
The crew uses available covered and concealed routes or moves under the cover of smoke/weather.	1	2	3	4	5
The crew coordinates its movement with other tanks in the platoon/section.	1	2	3	4	5
The TC selects primary, alternate, and supplemental positions appropriate to the tactical situation (defense or overwatch).	1	2	3	4	5
The crew properly occupies and moves between hide, turret down, and hull down positions per the tactical situation.	1	2	3	4	5
The TC directs movement out of firing positions to avoid effective anti-tank fires.	1	2	3	4	5
The driver maintains a steady firing platform and a speed appropriate to the tactical situation.	1	2	3	4	5
The crew avoids untrafficable terrain.	1	2	3	4	5

Total: Qualified _____ Superior _____ Distinguished _____

7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26

27 28 29 30 31 32 33 34 35

Crew - Initial Standard Setting Phase

REACTION DRILLS

The crew reacts immediately to contact during movement. The crew returns fire, reports*, and continues to move:

- If the tank is engaged by an ATGM, the crew turns the tank and turret toward the direction of the primary threat. The driver performs random evasive maneuvers while moving to the nearest covered concealed position. The gunner engages the enemy vehicle/position with suppresive fires. When appropriate, the TC employs smoke grenades or directs the driver to make smoke.

- If a platoon/section action drill is specified, the driver immediately turns the tank in the direction specified and comes on line with the other tank(s) in the formation. The turret is rotated to the direction of the primary threat.

- If a platoon/section contact drill is specified, the turret is traversed to the specified direction while the driver continues to move the tank in the original direction.

* Contact reports are evaluated in a separate evaluation criteria.

Rating Scales

	Never	Rarely	Often	Usually	Always
The crew reacts immediately to contact or drill commands.	1	2	3	4	5
The crew returns fire on contact.	1	2	3	4	5
The crew turns the tank/turret in the appropriate direction per the specified drill or the tactical situation.	1	2	3	4	5
The crew effectively avoids anti-tank fires by evasive maneuver and/or the use of smoke.	1	2	3	4	5

Total: Qualified _____ Superior _____ Distinguished _____

4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

Crew - Initial Standard Setting Phase

CONTACT REPORTS

Contact reports are timely, clear, and concise. Contact reports contain an accurate cardinal direction. The crew accurately reports the type of target.

Rating Scales

	Never	Rarely	Often	Usually	Always
The crew immediately reports contact.	1	2	3	4	5
The crew accurately reports direction of the contact to the nearest cardinal direction.	1	2	3	4	5
The crew accurately reports target types.	1	2	3	4	5
The crew transmits brief, clear contact reports.	1	2	3	4	5

Total: Qualified _____ Superior _____ Distinguished _____

4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

Crew - Initial Standard Setting Phase

SPOT REPORTS

Spot reports are accurate and comprehensive. Spot reports are clear and concise. Spot reports are transmitted as soon as practical (with emphasis on accuracy rather than timeliness).

Rating Scales

	Never	Rarely	Often	Usually	Always
The crew accurately reports threat vehicle type, number, and actions without error; and time of observation/engagement within 2 minutes.	1	2	3	4	5
The crew reports threat locations accurately within 200 meters.	1	2	3	4	5
The crew reports friendly actions accurately (number of targets destroyed within +/- 10%).	1	2	3	4	5
The crew transmits SPOT reports as soon as practical given the tactical situation.	1	2	3	4	5

Total: Qualified _____ Superior _____ Distinguished _____

4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

CREW EVALUATION CRITERIA

	Distinguished 1	2	3	4	5	Superior 1	2	3	4	5	Qualified 1	2	3	4	5
Search Procedure															
Acquisition Reports															
Normal Mode Fire Cmds. & Reengag.															
Degraded Mode & Subs. Fire Cmds.															
Movement															
Reaction Drills															
Spot Reports															
Contact Reports															

Crew Tally Sheet

Crew - Final Standard Setting Phase

SEARCH PROCEDURE

The crew searches in assigned sectors between engagements. Search activities are concentrated in the tank's primary sector but also includes 360° coverage commensurate with the tactical situation. Each crewman scans his entire sector and performs detailed searches of possible danger areas. Binoculars and night vision goggles are used to supplement the search during open-hatch operations. Vision blocks or night vision periscopes are used during closed hatch operations. Selected crew members continue searching during engagements as the situation permits. Standard sectors for each crew member are:

TC: Left limit of the tank's primary sector to the tank's direct rear (i.e., 11 o'clock to 6 o'clock, with 12 o'clock being to the direct front of the tank, or center of the primary sector).

GUNNER: Left limit to right limit of the tank's primary sector (i.e., 11 o'clock to 1 o'clock).

LOADER: Tank's direct rear to right limit of the tank's primary sector (i.e., 6 o'clock to 1 o'clock).

DRIVER: Left front fender to right front fender of the tank when the view is not masked by terrain.

Individual sectors may be situationally adjusted, particularly according to the mutual support provided by other tanks within the section/platoon. However, the basic principles of all-round security, concentration on the primary sector, and equitable division of labor will not be compromised.

Facets

- Crew members search between and during engagements as crew duties permit.
- Crew members concentrate searches in the tank's primary sector.
- The crew provides 360° security according to the tactical situation.
- Crewmen scan their entire sectors and perform detailed searches of danger areas.
- Crewmen use binoculars or night vision goggles - open hatch and vision blocks or night vision periscopes - closed hatch.

5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

Crew - Final Standard Setting Phase

ACQUISITION REPORTS

Crew members use acquisition reports to alert the TC and gunner to the presence of a threat, the nature of that threat, and its specific location. Reports are timely, brief, comprehensive, and as accurate as practical under the situation. Target signatures are reported if targets cannot be positively identified.

Facets

- Crew members transmit timely reports.
- Crew members transmit brief reports.
- Crew members give accurate target descriptions.
- Crew members give accurate target locations.

4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

NORMAL MODE FIRE COMMANDS AND REENGAGEMENT

Normal mode fire commands are used when the tank is fully operational. Normal fire commands are timely, brief, comprehensive and accurate. The correct ammunition is selected to engage each target according to the tactical situation. Targets are engaged in order of relative threat and according to existing section/platoon fire patterns and techniques. Corrections are used when required. Abbreviated fire commands are used when appropriate. Crew duties (e.g., announcing "UP" and "IDENTIFIED") are performed as required. Targets are reengaged if the first round misses.

Facets

- The TC gives timely fire commands.
- The TC gives brief, comprehensive fire commands (including abbreviated fire commands, if used).
- The TC selects ammunition appropriate to the target and tactical situation.
- The TC selects and sequences targets (multiple target engagements) per target classifications and section/platoon fire patterns/techniques.
- The TC gives accurate fire commands (target descriptions).
- The TC gives proper corrections in fire commands (as required).
- Crew members give timely, correct verbal responses (i.e., crew duties).
- The crew reengages targets after first round misses.

8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27

28 29 30 31 32 33 34 35 36 37 38 39 40

Crew - Final Standard Setting Phase

DEGRADED MODE AND SUBSEQUENT FIRE COMMANDS

The TC modifies the fire command according to known or suspected fire control degradations. Fire commands are timely, brief, comprehensive, and accurate. The TC selects ammunition appropriate to the target and tactical situation. The crew engages targets according to target classification and existing section/platoon fire patterns and techniques. The TC issues the direction element of the fire command when required. The TC estimates the range or asks an adjacent tank for range information when needed and takes appropriate action (e.g., specifies battlesight or indexes the range). The TC announces corrections when required. Crew duties are performed as required. The gunner/TC use standard adjustments or subsequent fire commands based on crew/adjacent tank observations (sensings) when first round misses occur. If a degraded condition is discovered during an engagement, the crew takes appropriate immediate action to resolve the engagement then isolates and compensates for the fault at the earliest opportunity.

Facets

- The TC gives timely fire commands.
- The TC gives brief, comprehensive fire commands appropriate to degraded mode conditions
- The TC selects ammunition appropriate to the target and tactical situation.
- The TC specifies battlesight when appropriate.
- The TC selects and sequences targets per target classifications and section/platoon fire patterns/techniques.
- The TC gives brief, effective direction elements when required.
- The TC gives accurate fire commands (target description, direction, range).
- The TC gives proper corrections in fire commands as required.
- Crew members give timely, correct verbal responses (i.e., crew duties).
- The TC/gunner uses standard adjustments/subsequent fire commands per crew/adjacent tank observations.
- The crew isolates, corrects, compensates for degraded conditions ASAP.

11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50

51 52 53 54 55

Crew - Final Standard Setting Phase

MOVEMENT

The crew moves along available covered and concealed routes* and takes advantage of the tank's speed and available obscurants (e.g., weather, smoke) when crossing danger areas. The crew maintains formation (pace and interval) with the platoon/section. The TC selects primary, alternate, and supplemental positions appropriate to the tactical situation. The crew properly occupies and moves between hide, turret down, and hull down positions per the tactical situation. The TC controls movement into hull down positions to prevent premature exposure in coordination with his section leader or wingman per the section/platoon firing technique. The TC directs movement out of the firing position to avoid effective anti-tank fires and to minimize exposure between engagements. The driver maintains a steady firing platform (smooth acceleration, braking, turning) during engagements. The crew avoids untrafficable terrain.

* The evaluation criteria may be modified to the extent that movement is limited to established routes and firing positions on some training facilities.

Facets

- The crew uses available covered and concealed routes or moves under the cover of smoke/weather.
- The crew coordinates its movement with other tanks in the platoon/section.
- The TC selects primary, alternate, and supplemental positions appropriate to the tactical situation (defense or overwatch).
- The crew properly occupies and moves between hide, turret down, and hull down positions per the tactical situation.
- The TC directs movement out of firing positions to avoid effective anti-tank fires.
- The driver maintains a steady firing platform and a speed appropriate to the the tactical situation.
- The crew avoids untrafficable terrain.

7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26

27 28 29 30 31 32 33 34 35

Crew - Final Standard Setting Phase

REACTION DRILLS

The crew reacts immediately to contact during movement. The crew returns fire, reports*, and continues to move:

- If the tank is engaged by an ATGM, the crew turns the tank and turret toward the direction of the primary threat. The driver performs random evasive maneuvers while moving to the nearest covered concealed position. The gunner engages the enemy vehicle/position with suppresive fires. When appropriate, the TC employs smoke grenades or directs the driver to make smoke.

- If a platoon/section action drill is specified, the driver immediately turns the tank in the direction specified and comes on line with the other tank(s) in the formation. The turret is rotated to the direction of the primary threat.

- If a platoon/section contact drill is specified, the turret is traversed to the specified direction while the driver continues to move the tank in the original direction.

* Contact reports are evaluated in a separate evaluation criteria.

Facets

- The crew reacts immediately to contact or drill commands.
- The crew returns fire on contact.
- The crew turns the tank/turret in the appropriate direction per the specified drill or the tactical situation.
- The crew effectively avoids anti-tank fires by evasive maneuver and/or the use of smoke.

4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

CONTACT REPORTS

Contact reports are timely, clear, and concise. Contact reports contain an accurate cardinal direction. The crew accurately reports the type of target.

Facets

- The crew immediately reports contact.
- The crew accurately reports direction of the contact to the nearest cardinal direction.
- The crew accurately reports target types.
- The crew transmits brief, clear contact reports.

4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

Crew - Final Standard Setting Phase

SPOT REPORTS

Spot reports are accurate and comprehensive. Spot reports are clear and concise. Spot reports are transmitted as soon as practical (with emphasis on accuracy rather than timeliness).

Facets

- The crew accurately reports threat vehicle type, number, and actions without error; and time of observation/engagement within 2 minutes.
- The crew reports threat locations accurately within 200 meters.
- The crew reports friendly actions accurately (number of targetsdestroyed within +/- 10%).
- The crew transmits SPOT reports as soon as practical given the tactical situation.

4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

Annex 3

Platoon Standard Setting Hand-Outs and Response Sheets

Platoon Performance Levels

- **Distinguished.** A distinguished platoon is among the best in the army. A platoon operating at this level makes almost no tactical and procedural errors. It is very well coordinated (i.e., battle drills appear well practiced) and effectively employs SOP.

- **Superior.** A superior platoon may make a few tactical and procedural errors, but their errors are not likely to endanger themselves or other platoons. It is generally well coordinated (i.e., battle drills appear fairly well practiced) and effectively employs SOP.

- **Qualified.** A qualified platoon makes some tactical and procedural errors which may endanger themselves and/or other platoons, but for the most part their performance is acceptable. It is coordinated, but battle drills could use more practice. It generally employs effective SOP.

- **Unqualified.** An unqualified platoon is among the worst in the army. These platoons make so many tactical and procedural errors that they endanger themselves and other platoons. It is completely uncoordinated and appears confused. Its use of SOP is ineffective.

Rating Scale

1	2	3	4	5
poor performance				excellent performance

Hand-Out 2

Platoon - Initial Standard Setting Phase

ROUTE SELECTION*

The platoon uses routes of movement appropriate to the tactical situation. The routes used provide adequate cover and concealment for the platoon, or if adequate cover and concealment is not available, the platoon uses the route that provides the best available cover and concealment. Available weather (e.g., fog, heavy rain, snow) or smoke is used to supplement natural cover and concealment. The platoon avoids untrafficable terrain.

* Application of this evaluation criteria is dependent upon the amount of freedom afforded the platoon in the exercise. If the exercise conditions strictly restrict freedom of maneuver, applicable items within this criterion are not evaluated.

Rating Scales

	Never	Rarely	Often	Usually	Always
The platoon uses a route of movement appropriate to the tactical situation.	1	2	3	4	5
The platoon uses a route with adequate (or the best available) cover and concealment.	1	2	3	4	5
The platoon uses reduced visability when available to supplement natural cover and concealment.	1	2	3	4	5
The platoon avoids untrafficable terrain to the extent possible.	1	2	3	4	5

Total: Qualified _____ Superior _____ Distinguished _____

4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

Platoon - Initial Standard Setting Phase

MOVEMENT

Platoon movement techniques and formations are suitable to the tactical situation. The relative positions of and intervals between vehicles resemble the formation templates, adjusted according to the terrain being traversed. Rates of movement are appropriate to the tactical situation and allow all tanks in the platoon to maintain formation. When performing bounding overwatch internally or within a larger unit, the bounding element avoids outdistancing the effectiveness of the overwatching element. The platoon quickly changes direction and formation when required by the tactical situation.

Rating Scales

	Never	Rarely	Often	Usually	Always
The platoon uses movement techniques and formations suitable to the tactical situation.	1	2	3	4	5
Tanks maintain formation (individual tanks' rates of movement, positions within formation are relatively constant).	1	2	3	4	5
The platoon adjusts the formation per the terrain being traversed.	1	2	3	4	5
The platoon moves at a rate appropriate to the tactical situation.	1	2	3	4	5
Bounding elements remain within effective overwatch range.	1	2	3	4	5
The platoon changes direction and formation quickly when required.	1	2	3	4	5

Total: Qualified _____ Superior _____ Distinguished _____

6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

26 27 28 29 30

Platoon - Initial Standard Setting Phase

POSITION SELECTION*

The platoon selects positions (battle positions or overwatch positions) that are suitable to the tactical situation. The positions provide adequate observation and fields of fire, cover and concealment, and room for independent maneuver within the platoon. Individual tanks select (or the Pldr/PSG designate) adequate primary, alternate, and supplementary positions.

* Application of this evaluation criteria is dependent upon the amount of freedom afforded the platoon in the exercise. If the exercise conditions strictly restrict the positions available to the platoon, applicable items within this criteria are not evaluated.

Rating Scales

	Never	Rarely	Often	Usually	Always
The platoon occupies battle/overwatch positions suitable to the tactical situation.	1	2	3	4	5
The platoon has adequate observation fields of fire from selected positions.	1	2	3	4	5
Tanks within the platoon select appropriate primary, alternate, and supplementary positions.	1	2	3	4	5
The platoon selects positions with adequate cover and concealment (covered/concealed hide positions and routes between firing positions).	1	2	3	4	5
Tanks can maneuver independently within the position without interfering with each other.	1	2	3	4	5

Total: Qualified _____ Superior _____ Distinguished _____

5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

Platoon - Initial Standard Setting Phase

INTRA-POSITION MOVEMENT

Tanks within the platoon properly occupy hide, turret down, or hull down positions according to the tactical situation. When not in contact, the platoon adheres to movement restrictions imposed by superior headquarters. Time and movement restrictions permitting, the platoon rehearses movement within and between defensive positions. When in contact, tanks remain in firing positions as long as possible but move to avoid decisive engagement. Tanks move quickly between fighting positions using the best available cover and concealment. Tanks coordinate their movement and fires.

Rating Scales

	Never	Rarely	Often	Usually	Always
Tanks properly occupy hide, turret down, or hull down positions per tactical situation.	1	2	3	4	5
Tanks coordinate their movement and fires.	1	2	3	4	5
Tanks stay in firing positions as long as possible.	1	2	3	4	5
Tanks move to avoid decisive engagement.	1	2	3	4	5
Tanks move quickly between fighting positions along covered and concealed routes.	1	2	3	4	5
The platoon rehearses movement within and between positions (time/movement restrictions permitting).	1	2	3	4	5
The platoon adheres to movement restrictions from higher (out of contact).	1	2	3	4	5

Total: Qualified ______ Superior ______ Distinguished ______

7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26

27 28 29 30 31 32 33 34 35

Platoon - Initial Standard Setting Phase

ORIENTATION (DEFENSE)

The platoon concentrates search activities on the platoon's primary sector or in the primary direction of the threat. Tank primary weapons systems are oriented within the tanks' primary sectors. Tanks provide mutual support within the platoon. All-round security is accomplished by mounted and dismounted observers and through mutual support with adjacent platoons. The platoon complies with the Readiness Condition (REDCON) specified by superior headquarters. On contact, the platoon reports and masses fires per the standing engagement criteria.

Rating Scales

	Never	Rarely	Often	Usually	Always
Crews concentrate search efforts in the platoon's primary sector.	1	2	3	4	5
Tanks provide mutual support within the platoon.	1	2	3	4	5
The platoon maintains all-round security.	1	2	3	4	5
The platoon complies with REDCON specified by higher.	1	2	3	4	5
On contact the platoon reports and masses fires per engagement criteria.	1	2	3	4	5

Total: Qualified _____ Superior _____ Distinguished _____

5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

Platoon - Initial Standard Setting Phase

ORIENTATION (OFFENSE)

When moving, tanks orient on the primary threat or according to the section/platoon formation. When in overwatch, tanks continuously orient on likely enemy positions that may threaten the bounding element and shift from one likely enemy position to the next in coordination with the bounding element's movement. Tanks provide mutual support within the platoon and with adjacent elements. On contact, tanks return fire, deploy, and report.

Rating Scales

	Never	Rarely	Often	Usually	Always
Tanks orient on the primary threat.	1	2	3	4	5
Tanks maintain orientations appropriate to the section/platoon formation.	1	2	3	4	5
Tanks provide mutual support within the platoon and with adjacent elements.	1	2	3	4	5
In overwatch:					
Tanks continuously overwatch.	1	2	3	4	5
Tanks adjust orientation per the bounding element's progress.	1	2	3	4	5
On contact:					
Tanks immediately return fire.	1	2	3	4	5
Tanks immediately report contact.	1	2	3	4	5
The platoon rapidly performs drills per tactical situation.	1	2	3	4	5

Total: Qualified _____ Superior _____ Distinguished _____

8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27

28 29 30 31 32 33 34 35 36 37 38 39 40

Platoon - Initial Standard Setting Phase

DIRECT FIRES

The platoon's fires are distributed over the length and depth of the target array per superior headquarters' fire distribution order. Targets within the platoon's area of responsibility are engaged in order of relative danger and from near to far within each danger classification. The platoon fire pattern and volume of fires is appropriate to the tactical situation. The platoon shifts or ceases its fires when appropriate.

Rating Scales

	Never	Rarely	Often	Usually	Always
The platoon properly distributes its fires.	1	2	3	4	5
The platoon complies within higher's fire distribution scheme.	1	2	3	4	5
Tanks engage targets in sequence per danger classification.	1	2	3	4	5
Tanks engage targets in sequence from near to far.	1	2	3	4	5
The platoon engages targets at a rate (volume of fire) appropriate to the tactical situation.	1	2	3	4	5
The platoon shifts/ceases fires when appropriate.	1	2	3	4	5

Total: Qualified _____ Superior _____ Distinguished _____

6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
26 27 28 29 30

Platoon - Initial Standard Setting Phase

COMMUNICATION

Radio communication (internally and externally) complies with proper Radio-Telephone Procedure (RTP) (i.e., operators correctly use PROWORDS, brevity codes, ciphers, and SOP). Transmissions are clear and concise. The network control station (NCS) effectively maintains network discipline. Radio security equipment, visual communication, wire communications, and messengers are used when possible to reduce the platoon's electronic signature. Transmissions, particularly reports, are as timely and accurate as the situation permits.

Rating Scales

	Never	Rarely	Often	Usually	Always
Operators use proper RTP.	1	2	3	4	5
The NCS effectively maintains net discipline.	1	2	3	4	5
Operators transmit clear, concise radio messages.	1	2	3	4	5
The platoon uses radio security equipment if available.	1	2	3	4	5
The platoon uses visual communication when possible.	1	2	3	4	5
The platoon uses wire communications when practical.	1	2	3	4	5
The platoon uses messengers when practical.	1	2	3	4	5
Operators transmit timely, accurate radio messages.	1	2	3	4	5

Total: Qualified _____ Superior _____ Distinguished _____

8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27

28 29 30 31 32 33 34 35 36 37 38 39 40

PLATOON EVALUATION CRITERIA

	Distinguished 1	2	3	4	5	Superior 1	2	3	4	5	Qualified 1	2	3	4	5
Route Selection															
Movement															
Position Selection															
Intra-Position Movement															
Orientation (Defense)															
Orientation (Offense)															
Direct Fires															
Communication															

Platoon Tally Sheet

Platoon - Final Standard Setting Phase

ROUTE SELECTION*

The platoon uses routes of movement appropriate to the tactical situation. The routes used provide adequate cover and concealment for the platoon, or if adequate cover and concealment is not available, the platoon uses the route that provides the best available cover and concealment. Available weather (e.g., fog, heavy rain, snow) or smoke is used to supplement natural cover and concealment. The platoon avoids untrafficable terrain.

* Application of this evaluation criteria is dependent upon the amount of freedom afforded the platoon in the exercise. If the exercise conditions strictly restrict freedom of maneuver, applicable items within this criterion are not evaluated.

Facets

- The platoon uses a route of movement appropriate to the tactical situation.
- The platoon uses a route with adequate (or the best available) cover and concealment.
- The platoon uses reduced visability when available to supplement natural cover and concealment.
- The platoon avoids untrafficable terrain to the extent possible.

4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

Platoon - Final Standard Setting Phase

MOVEMENT

Platoon movement techniques and formations are suitable to the tactical situation. The relative positions of and intervals between vehicles resemble the formation templates, adjusted according to the terrain being traversed. Rates of movement are appropriate to the tactical situation and allow all tanks in the platoon to maintain formation. When performing bounding overwatch internally or within a larger unit, the bounding element avoids outdistancing the effectiveness of the overwatching element. The platoon quickly changes direction and formation when required by the tactical situation.

Facets

- The platoon uses movement techniques and formations suitable to the tactical situation.
- Tanks maintain formation (individual tanks' rates of movement, positions within formation are relatively constant).
- The platoon adjusts the formation per the terrain being traversed.
- The platoon moves at a rate appropriate to the tactical situation.
- Bounding elements remain within effective overwatch range.
- The platoon changes direction and formation quickly when required.

6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

26 27 28 29 30

Platoon - Final Standard Setting Phase

POSITION SELECTION*

The platoon selects positions (battle positions or overwatch positions) that are suitable to the tactical situation. The positions provide adequate observation and fields of fire, cover and concealment, and room for independent maneuver within the platoon. Individual tanks select (or the Pldr/PSG designate) adequate primary, alternate, and supplementary positions.

* Application of this evaluation criteria is dependent upon the amount of freedom afforded the platoon in the exercise. If the exercise conditions strictly restrict the positions available to the platoon, applicable items within this criteria are not evaluated.

Facets

- The platoon occupies battle/overwatch positions suitable to the tactical situation.
- The platoon has adequate observation fields of fire from selected positions.
- Tanks within the platoon select appropriate primary, alternate, and supplementary positions.
- The platoon selects positions with adequate cover and concealment (covered/concealed hide positions and routes between firing positions).
- Tanks can maneuver independently within the position without interfering with each other.

5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

Platoon - Final Standard Setting Phase

INTRA-POSITION MOVEMENT

Tanks within the platoon properly occupy hide, turret down, or hull down positions according to the tactical situation. When not in contact, the platoon adheres to movement restrictions imposed by superior headquarters. Time and movement restrictions permitting, the platoon rehearses movement within and between defensive positions. When in contact, tanks remain in firing positions as long as possible but move to avoid decisive engagement. Tanks move quickly between fighting positions using the best available cover and concealment. Tanks coordinate their movement and fires.

Facets

- Tanks properly occupy hide, turret down, or hull down positions per tactical situation.
- Tanks coordinate their movement and fires.
- Tanks stay in firing positions as long as possible.
- Tanks move to avoid decisive engagement.
- Tanks move quickly between fighting positions along covered and concealed routes.
- The platoon rehearses movement within and between positions (time/movement restrictions permitting).
- The platoon adheres to movement restrictions from higher (out of contact).

7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26

27 28 29 30 31 32 33 34 35

Platoon - Final Standard Setting Phase

ORIENTATION (DEFENSE)

The platoon concentrates search activities on the platoon's primary sector or in the primary direction of the threat. Tank primary weapons systems are oriented within the tanks' primary sectors. Tanks provide mutual support within the platoon. All-round security is accomplished by mounted and dismounted observers and through mutual support with adjacent platoons. The platoon complies with the Readiness Condition (REDCON) specified by superior headquarters. On contact, the platoon reports and masses fires per the standing engagement criteria.

Facets

- Crews concentrate search efforts in the platoon's primary sector.
- Tanks provide mutual support within the platoon.
- The platoon maintains all-round security.
- The platoon complies with REDCON specified by higher.
- On contact the platoon reports and masses fires per engagement criteria.

5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

ORIENTATION (OFFENSE)

When moving, tanks orient on the primary threat or according to the section/platoon formation. When in overwatch, tanks continuously orient on likely enemy positions that may threaten the bounding element and shift from one likely enemy position to the next in coordination with the bounding element's movement. Tanks provide mutual support within the platoon and with adjacent elements. On contact, tanks return fire, deploy, and report.

Facets

- Tanks orient on the primary threat.
- Tanks maintain orientations appropriate to the section/platoon formation.
- Tanks provide mutual support within the platoon and with adjacent elements.

In overwatch:

- Tanks continuously overwatch.
- Tanks adjust orientation per the bounding element's progress.

On contact:

- Tanks immediately return fire.
- Tanks immediately report contact.
- The platoon rapidly performs drills per tactical situation.

8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27

28 29 30 31 32 33 34 35 36 37 38 39 40

Platoon - Final Standard Setting Phase

DIRECT FIRES

The platoon's fires are distributed over the length and depth of the target array per superior headquarters' fire distribution order. Targets within the platoon's area of responsibility are engaged in order of relative danger and from near to far within each danger classification. The platoon fire pattern and volume of fires is appropriate to the tactical situation. The platoon shifts or ceases its fires when appropriate.

Facets

- The platoon properly distributes its fires.
- The platoon complies within higher's fire distribution scheme.
- Tanks engage targets in sequence per danger classification.
- Tanks engage targets in sequence from near to far.
- The platoon engages targets at a rate (volume of fire) appropriate to the tactical situation.
- The platoon shifts/ceases fires when appropriate.

6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

26 27 28 29 30

COMMUNICATION

Radio communication (internally and externally) complies with proper Radio-Telephone Procedure (RTP) (i.e., operators correctly use PROWORDS, brevity codes, ciphers, and SOP). Transmissions are clear and concise. The network control station (NCS) effectively maintains network discipline. Radio security equipment, visual communication, wire communications, and messengers are used when possible to reduce the platoon's electronic signature. Transmissions, particularly reports, are as timely and accurate as the situation permits.

Facets

- Operators use proper RTP.
- The NCS effectively maintains net discipline.
- Operators transmit clear, concise radio messages.
- The platoon uses radio security equipment if available.
- The platoon uses visual communication when possible.
- The platoon uses wire communications when practical.
- The platoon uses messengers when practical.
- Operators transmit timely, accurate radio messages.

8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27

28 29 30 31 32 33 34 35 36 37 38 39 40

Annex 4

Platoon Leader/Platoon Sergeant Standard Setting
Hand-Outs and Response Sheets

Platoon Leader/Platoon Sergeant Performance Levels

- **Distinguished.** A distinguished platoon leader/platoon sergeant is among the best in the army. A platoon leader/platoon sergeant operating at this level makes almost no tactical and procedural errors.
- **Superior.** A superior platoon leader/platoon sergeant may make a few tactical and procedural errors, but his errors are not likely to endanger himself or his platoon.
- **Qualified.** A qualified platoon leader/platoon sergeant makes some tactical and procedural errors which may endanger himself and/or his platoon, but for the most part his performance is acceptable.
- **Unqualified.** An unqualified platoon leader/platoon sergeant is among the worst in the army. These platoon leaders/platoon sergeants make so many tactical and procedural errors that they endanger themselves and their platoons.

Rating Scale

1	2	3	4	5
poor performance				excellent performance

Hand-Out 3

Platoon Leader/Platoon Sergeant - Initial Standard Setting Phase

FIRE PLANNING

The platoon leader/platoon sergeant (Pldr/PSG) orients the platoon to the terrain (e.g., points out key terrain and avenues of approach), designates individual vehicle positions (i.e., primary and supplemental), and sectors for each vehicle position. He designates direct fire control measures (e.g., TRPs, engagement areas) to partition the platoon sector and to provide for mutual support both within the platoon and with adjacent platoon elements. The Pldr/PSG establishes engagement criteria for the platoon. He establishes standing fire patterns and firing techniques based on likely enemy actions. Time permitting, the Pldr/PSG consolidates a platoon fire plan. He verifies that individual crews/crew members understand the platoon fire plan, how their tank supports the platoon plan, and are properly oriented to the terrain.

Rating Scales

	Never	Rarely	Often	Usually	Always
The Pldr/PSG orients the platoon to the terrain.	1	2	3	4	5
The Pldr/PSG designates primary and supplemental positions for each tank.	1	2	3	4	5
The Pldr/PSG designates individual sectors for each primary and supplemental vehicle position.	1	2	3	4	5
The Pldr/PSG designates direct fire control measures appropriate to the tactical situation.	1	2	3	4	5
The Pldr/PSG plans for mutual support both within the platoon and with adjacent platoons.	1	2	3	4	5
The Pldr/PSG documents the platoon fire command if time permits.	1	2	3	4	5
The Pldr/PSG verifies sector coverage from turret down and hull down positions.	1	2	3	4	5

Total: Qualified _____ Superior _____ Distinguished _____

7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26

27 28 29 30 31 32 33 34 35

Platoon Leader/Platoon Sergeant - Initial Standard Setting Phase

FIRE COMMANDS

The platoon leader/platoon sergeant (Pldr/PSG) uses fire commands to control and coordinate the platoon's direct fires. The Pldr/PSG transmits only the minimum essential information required to bring appropriate fires on the enemy formation or position (e.g., if a standing fire pattern is in effect, no fire pattern is given in the platoon fire command). The specified fire pattern and firing technique are appropriate to the tactical situation.

Rating Scales

	Never	Rarely	Often	Usually	Always
The Pldr/PSG issues clear, concise fire commands.	1	2	3	4	5
The Pldr/PSG selects fire patterns and firing techniques appropriate to the tactical situation.	1	2	3	4	5
The Pldr/PSG effectively controls and coordinates platoon fires.	1	2	3	4	5

Total: Qualified ______ Superior ______ Distinguished ______

3 4 5 6 7 8 9 10 11 12 13 14 15

Platoon Leader/Platoon Sergeant - Initial Standard Setting Phase

REQUEST INDIRECT FIRES

Indirect fires are coordinated with the platoon's own movement and fires. Fires are preplanned to the extent possible. Fires may be controlled by the company team commander through the FIST. The platoon leader/platoon sergeant (Pldr/PSG) may request or shift fires as required during the operation, particularly if the CO and/or FIST cannot observe as effectively as the Pldr/PSG. The Pldr/PSG plans for and requests indirect fires regardless of their expected availability.

In the offense, indirect fires are used to suppress known and/or suspected enemy positions and to reinforce direct fires. Indirect smoke is employed to screen the platoon from enemy observation and fires.

In the defense, the Pldr/PSG employs indirect fires to reinforce direct fires, to force the enemy formation to "button up," and to suppress enemy overwatch positions. Fires and smoke are used to cover movement from one battle position to the next.

Rating Scales

	Never	Rarely	Often	Usually	Always
The Pldr/PSG designates indirect fire control measures appropriate to the tactical situation.	1	2	3	4	5
The Pldr/PSG makes clear, concise, and accurate FA/Mort calls for fire.	1	2	3	4	5
The Pldr/PSG effectively uses FA/Mort fires when available to suppress enemy positions/formations and/or to reinforce direct fires.	1	2	3	4	5
The Pldr/PSG effectively uses FA/Mort smoke when available to screen the platoon from enemy observation and fires.	1	2	3	4	5
The Pldr/PSG shifts FA/Mort fires in coordination with the platoon's movement and fires.	1	2	3	4	5

Total: Qualified ______ Superior ______ Distinguished ______

5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

Platoon Leader/Platoon Sergeant - Initial Standard Setting Phase

OPERATIONS ORDERS

Operations orders are clear and concise. The platoon leader/platoon sergeant (Pldr/PSG) conveys all essential information for the upcoming operation in the OPORD format. He omits any non-essential information from the company team or higher level OPORD. The scheme of maneuver conforms with the company team commander's intent and allows for mutual support within the platoon and with adjacent elements. Designated routes make maximum (practical) use of cover and concealment within the boundaries specified by the company commander. The order specifies how known and likely enemy positions will be attacked (offensive) or how likely enemy actions will be countered (defensive). The Pldr/PSG also addresses practical contingencies.

Rating Scales

	Never	Rarely	Often	Usually	Always
The Pldr/PSG issues clear, concise OPORDS.	1	2	3	4	5
The Pldr/PSG communicates all essential information (excludes non-essential information) in OPORD format.	1	2	3	4	5
The Pldr/PSG communicates a scheme of maneuver that:					
conforms with the company team commander's intent.	1	2	3	4	5
provides for mutual support within the platoon and with adjacent platoons.	1	2	3	4	5
effectively uses cover and concealment without violating the company team commander's scheme of maneuver.	1	2	3	4	5
The Pldr/PSG explains how the platoon will react to known/likely enmey actions.	1	2	3	4	5
The Pldr/PSG addresses practical contingencies.	1	2	3	4	5

Total: Qualified ______ Superior ______ Distinguished ______

7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26

27 28 29 30 31 32 33 34 35

Platoon Leader/Platoon Sergeant - Initial Standard Setting Phase

FRAGMENTARY ORDERS

FRAGOs are used to change or refine the standing order or plan. FRAGOs are not employed arbitrarily when the standing order or plan is sufficient for the existing situation. FRAGOs may be used to prompt preplanned actions when necessary. Actions directed in FRAGOs conform with the commander's intent for the current operation. FRAGOs may be in response to enemy activity or company team FRAGOs. FRAGOs are clear, concise, and timely.

Rating Scales

	Never	Rarely	Often	Usually	Always
The Pldr/PSG issues FRAGOs only when necessary to refine or modify the standing order or plan.	1	2	3	4	5
The Pldr/PSG directs actions by FRAGO that comply with the commander's intent.	1	2	3	4	5
The Pldr/PSG issues clear, concise, and timely FRAGOs.	1	2	3	4	5

Total: Qualified ______ Superior ______ Distinguished ______

3 4 5 6 7 8 9 10 11 12 13 14 15

Platoon Leader/Platoon Sergeant - Initial Standard Setting Phase

SUPERVISION

The platoon leader/platoon sergeant (Pldr/PSG) questions and rehearses subordinates to ensure that orders are received and understood. Subordinates' activities are monitored during preparation and execution to ensure mission accomplishment. The Pldr/PSG corrects subordinates when he observes performance deficiencies. Corrective actions are brief and specific to demonstrated deficiencies. The amount of supervision exercised is adjusted based upon the capability of subordinates: the Pldr/PSG neither over-controls proficient crews nor under-controls novice crews.

Rating Scales

	Never	Rarely	Often	Usually	Always
The Pldr/PSG verifies subordinates' understanding of critical information (e.g., key events, terrain orientation, control measures).	1	2	3	4	5
The Pldr/PSG resolves likely problems during OPORDS, rehearsals, inspections, and/or back-briefings.	1	2	3	4	5
The Pldr/PSG monitors subordinates during execution and corrects deficiencies corrected as soon as practicable.	1	2	3	4	5
The Pldr/PSG issues clear, concise, and specific directives to correct demonstrated deficiencies.	1	2	3	4	5
The Pldr/PSG uses situational leadership (i.e., exercises the amount of supervision appropriate to subordinates' demonstrated capabilities.	1	2	3	4	5

Total: Qualified ______ Superior ______ Distinguished ______

5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

PLATOON LEADER/PLATOON SERGEANT EVALUATION CRITERIA

	Distinguished					Superior					Qualified				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Fire Planning															
Fire Commands															
Request Indirect Fires															
Operations Orders															
Fragmentary Orders															
Supervision															

Platoon Leader Tally Sheet

Platoon Leader/Platoon Sergeant - Final Standard Setting Phase

FIRE PLANNING

The platoon leader/platoon sergeant (Pldr/PSG) orients the platoon to the terrain (e.g., points out key terrain and avenues of approach), designates individual vehicle positions (i.e., primary and supplemental), and sectors for each vehicle position. He designates direct fire control measures (e.g., TRPs, engagement areas) to partition the platoon sector and to provide for mutual support both within the platoon and with adjacent platoon elements. The Pldr/PSG establishes engagement criteria for the platoon. He establishes standing fire patterns and firing techniques based on likely enemy actions. Time permitting, the Pldr/PSG consolidates a platoon fire plan. He verifies that individual crews/crew members understand the platoon fire plan, how their tank supports the platoon plan, and are properly oriented to the terrain.

Facets
- The Pldr/PSG orients the platoon to the terrain.
- The Pldr/PSG designates primary and supplemental positions for each tank.
- The Pldr/PSG designates individual sectors for each primary and supplemental vehicle position.
- The Pldr/PSG designates direct fire control measures appropriate to the tactical situation.
- The Pldr/PSG plans for mutual support both within the platoon and with adjacent platoons.
- The Pldr/PSG documents the platoon fire plan if time permits.
- The Pldr/PSG verifies sector coverage from turret down and hull down positions.

7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26

27 28 29 30 31 32 33 34 35

FIRE COMMANDS

The platoon leader/platoon sergeant (Pldr/PSG) uses fire commands to control and coordinate the platoon's direct fires. The Pldr/PSG transmits only the minimum essential information required to bring appropriate fires on the enemy formation or position (e.g., if a standing fire pattern is in effect, no fire pattern is given in the platoon fire command). The specified fire pattern and firing technique are appropriate to the tactical situation.

Facets
- The Pldr/PSG issues clear, concise fire commands.
- The Pldr/PSG selects fire patterns and firing techniques appropriate to the tactical situation.
- The Pldr/PSG effectively controls and coordinates platoon fires.

3 4 5 6 7 8 9 10 11 12 13 14 15

Platoon Leader/Platoon Sergeant - Final Standard Setting Phase

REQUEST INDIRECT FIRES

Indirect fires are coordinated with the platoon's own movement and fires. Fires are preplanned to the extent possible. Fires may be controlled by the company team commander through the FIST. The platoon leader/platoon sergeant (Pldr/PSG) may request or shift fires as required during the operation, particularly if the CO and/or FIST cannot observe as effectively as the platoon leader. The Pldr/PSG plans for and requests indirect fires regardless of their expected availability.

In the offense, indirect fires are used to suppress known and/or suspected enemy positions and to reinforce direct fires. Indirect smoke is employed to screen the platoon from enemy observation and fires.

In the defense, the Pldr/PSG employs indirect fires to reinforce direct fires, to force the enemy formation to "button up," and to suppress enemy overwatch positions. Fires and smoke are used to cover movement from one battle position to the next.

Facets

- The Pldr/PSG designates indirect fire control measures appropriate to the tactical situation.
- The Pldr/PSG makes clear, concise, and accurate FA/Mort calls for fire.
- The Pldr/PSG effectively uses FA/Mort fires when available to suppress enemy positions/formations and/or to reinforce direct fires.
- The Pldr/PSG effectively uses FA/Mort smoke when available to screen the platoon from enemy observation and fires.
- The Pldr/PSG shifts FA/Mort fires in coordination with the platoon's movement and fires.

5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

Platoon Leader/Platoon Sergeant - Final Standard Setting Phase

OPERATIONS ORDERS

Operations orders are clear and concise. The platoon leader/platoon sergeant (Pldr/PSG) conveys all essential information for the upcoming operation in the OPORD format. He omits any non-essential information from the company team or higher level OPORD. The scheme of maneuver conforms with the company team commander's intent and allows for mutual support within the platoon and with adjacent elements. Designated routes make maximum (practical) use of cover and concealment within the boundaries specified by the company commander. The order specifies how known and likely enemy positions will be attacked (offensive) or how likely enemy actions will be countered (defensive). The Pldr/PSG also addresses practical contingencies.

Facets

- The Pldr/PSG issues clear, concise OPORDs.
- The Pldr/PSG communicates all essential information (excludes non-essential information) in OPORD format.

The Pldr/PSG communicates a scheme of maneuver that:

- conforms with the company team commander's intent.
- provides for mutual support within the platoon and with adjacent platoons.
- effectively uses cover and concealment without violating the company team commander's scheme of maneuver.
- The Pldr/PSG explains how the platoon will react to known/likely enemy actions.
- The Pldr/PSG addresses practical contingencies.

7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26

27 28 29 30 31 32 33 34 35

FRAGMENTARY ORDERS

FRAGOs are used to change or refine the standing order or plan. FRAGOs are not employed arbitrarily when the standing order or plan is sufficient for the existing situation. FRAGOs may be used to prompt preplanned actions when necessary. Actions directed in FRAGOs conform with the commander's intent for the current operation. FRAGOs may be in response to enemy activity or company team FRAGOs. FRAGOs are clear, concise, and timely.

Facets

- The Pldr/PSG issues FRAGOs only when necessary to refine or modify the standing order or plan.
- The Pldr/PSG directs actions by FRAGO that comply with the commander's intent.
- The Pldr/PSG issues clear, concise, and timely FRAGOs.

3 4 5 6 7 8 9 10 11 12 13 14 15

Platoon Leader/Platoon Sergeant - Final Standard Setting Phase

SUPERVISION

The platoon leader/platoon sergeant (Pldr/PSG) questions and rehearses subordinates to ensure that orders are received and understood. Subordinates' activities are monitored during preparation and execution to ensure mission accomplishment. The Pldr/PSG corrects subordinates when he observes performance deficiencies. Corrective actions are brief and specific to demonstrated deficiencies. The amount of supervision exercised is adjusted based upon the capability of subordinates: the Pldr/PSG neither over-controls proficient crews nor under-controls novice crews.

Facets

- The Pldr/PSG verifies subordinates' understanding of critical information (e.g., key events, terrain orientation, control measures).
- The Pldr/PSG resolves likely problems in OPORDs, rehearsals, inspections, and/or back-briefings.
- The Pldr/PSG monitors subordinates during execution and corrects deficiencies as soon as practicable.
- The Pldr/PSG issues clear, concise, and specific directives to correct demonstrated deficiencies.
- The Pldr/PSG uses situational leadership (i.e., exercises the amount of supervision appropriate to subordinates' demonstrated capabilies.

5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

Appendix E

Gains in Experimental Power: Using Ammunition to Add Observations per Person or to Add Persons per Experimental Cell

CONTENTS

List of Tables

List of Figures

Observations and Experimental Power

The cost of testing the gunnery skills of tank crews and platoons is enormous simply because of the cost of the ammunition required. On the other hand, analysis of Tank Table VIII (the Army's periodic crew gunnery evaluation exercise) has shown it to have questionable reliability. For example, Hoffman (1989) found the correlations among the scores from the separate Table VIII tasks to be essentially zero. More recently, using a sample of first run Table VIII from a different location, D. A. Campshure (personal communication, March, 1990) found average intercorrelation among Table VIII score to be approximately .10. While small, that level of the interrelationship of the tasks is sufficient to produce a Cronbach's alpha (inter-item reliability) of .56.

It is certainly possible to estimate how measurement reliability would increase if crews fired more engagements. However, in the case of using Table VIII as a criterion test for comparing experimental groups of crews, reliability *per se* is less important than the within cell variance. This within cell variance is important because it serves as the error term in many ANOVA designs and, other things being equal, the smaller the error term the more powerful the experimental design. For convenience we will refer to this within cell variance as *experimental error* which is composed of variance attributable to individual differences. Variance in individual differences is, in turn, composed of true person variance and *measurement error* variance. Increasing test reliability by adding observations per person reduces measurement error variance which reduces experimental error variance.

If additional rounds are available for increasing test length, then an alternative strategy for reducing experimental error variance and increasing power is to use the rounds to test additional crews. The question becomes which research design more efficiently reduces experimental error variance: increasing test length or adding crews? Because of the high cost of ammunition, other costs associated with acquiring new persons may be quite small in comparison. Thus, total ammunition can be used as a resource metric for comparing research designs. Furthermore, by adding crews to the design, the additional ammunition used in the research may be paid for under the Army's normal STRAC (DA PAM 350-38, Department of Army, 1988a) allocation. Thus, recruiting additional crews may be less expensive to the research than adding ammunition.

Morrison (1988) describes procedures for calculating the minimum detectable difference (MDD) between two groups for any given sample size, cell variance, and power. Thus, his Equation 5 (p. 12), based on Welkowitz, Ewen, and Cohen (1982), can be used to plot changes in MDD ($\mu_1 - \mu_2$) as a result of changes in sample size (N), given values for power (represented by δ) and cell standard deviation (σ). Written in terms of variance rather than standard deviation, the relationship is:

$$\text{MDD} = \mu_1 - \mu_2 = \delta \times (2\sigma^2/N)^{.5} \quad (1)$$

If we base sample size estimates on total ammunition available, then MDD can be plotted as a function of ammunition. Such plots provide half of the needed information.

The other half of the comparison involves estimating changes in MDD if the same amounts of ammunition were used to increase the number of observations per crew without increasing the number of crews. Morrison's (1988) Equation 5 can be modified using generalizability theory formulas for calculating reliability (Brennan, 1983). Reliability is the ratio of true score or domain score variance to total observed variance. For tank crews, total observed variance (σ_T^2) is a function of true crew variance (σ_c^2) plus measurement error variance which is composed of test item variance (σ_i^2) and item by crew interaction variance (σ_{ci}^2) each adjusted for test length (n):

$$\sigma_T^2 = \sigma_c^2 + \frac{\sigma_i^2}{n} + \frac{\sigma_{ci}^2}{n}. \tag{2}$$

Longer tests have less error variance, and therefore less total variance. Less total variance on observed scores equates to smaller within cell or experimental error variance. Substituting the right side of Equation 2 for σ^2 in Equation 1 provides a mechanism for plotting changes in MDD as a function of test length n, where n is based on total ammunition.

To complete the comparison, initial estimates of σ_T^2, σ_c^2, σ_i^2, and σ_{ci}^2 are needed along with a specification for δ. Following Morrison's (1988) suggestion, the value for delta was selected to represent α = .05 and power (i.e., 1 - β) = .80. The associated value for δ is 2.8. Variance estimates were derived from Table VIII data provided by D. Campshure (personal communication, March, 1990). Specifically, σ_T^2 and σ_i^2 were calculated from the data. Total Table VIII score variance estimates σ_T^2, and the variance of the means of the ten Table VIII tasks provides an estimate of σ_i^2. Substituting the computed values for σ_T^2 and σ_i^2 into Equation 2 provides one equation with two unknowns, σ_c^2 and σ_{ci}^2. To solve for σ_c^2 and σ_{ci}^2 requires a second equation. That equation can be provided by a reliability formula. Specifically, Cronbach's alpha (r_{tt}) can be expressed as:

$$r_{tt} = \frac{\sigma_c^2}{\sigma_c^2 + \dfrac{\sigma_{ci}^2}{n}}. \tag{3}$$

Cronbach's alpha was computed from the data.

With σ_T^2, σ_i^2, and r_{tt} calculated from the data, Equations 2 and 3 were solved for σ_c^2 and σ_{ci}^2. These values, along with δ, provide the information needed to use Equations 1 and 2 to calculate changes in minimum detectable differences as a result of either adding test length or adding crews to the sample.

For a start point in these calculations, we assumed an initial sample size of 12 crews (one company) per group for a total of 24 crews in the experiment. We also assume a total hit portion of 70% of the 14 main gun target in the 10-task Table VIII. This is a convenient approximation of Table VIII data adjusted to provide an integer value of 20 average rounds per Table VIII, or 2 rounds per task (ignoring COAX targets). Thus, 240 additional rounds could support 12 additional crews or 6 extra crews per experimental group. Alternatively, 240 rounds could provide 10 addition rounds, or five

more tasks, for each of the original 24 crews. Minimum detectable differences were computed for amounts of ammunition at intervals up to a sufficient amount to test approximately two battalions, one per cell. That amount of ammunition is sufficient for the original 24 crews to complete a 10-task Table VIII nine times. Minimum detectable differences for both Table VIII score and average opening time were examined.

Tables E-1 and E-2 present observed variance, reliability, and the estimated variance components. Technically, two kinds of reliability are involved in this problem. Cronbach's alpha, referred to as "relative generalizability" in generalizability theory, treats items as a fixed sample used to make normative comparison among tested persons or crews. From that perspective, mean differences in items are irrelevant. On the other hand, if one were interested in sampling alternative gunnery tasks, similar but not identical to existing Table VIII tasks, then sampling of the items, such that some items are more difficult than others, would contribute to measurement error. Reliability in this case, termed "absolute generalizability," considers item variance (divided by the number of items) as error variance which is added to the denominator in Equation 3. While the values of σ_c^2 and σ_{ci}^2 were solved using relative generalizability formulas, the more appropriate reliability is absolute generalizability. Therefore each are presented in the tables. Reliability estimates are also presented for a single task test and for a standard ten task test.

The tables then present the comparisons for changes in minimum detectable differences between two groups for Table VIII score and average opening time when additional ammunition is allotted to new crews to increase sample size or allotted to existing crews to increase test length. The tables begin with a base allocation of 480 rounds which is sufficient to test 12 crews per cell for two cells on a standard 10-task Table VIII. MDD estimates are made for the two strategies of using increased amounts of ammunition in successive 200 round increments.

Figures E-1 and E-2 graphically summarize the relationship between additional ammunition resources and minimum detectable differences. Minimum detectable differences decrease for either strategy of using additional ammunition. However, the decrease is faster for the strategy of increasing sample size so that, for a given increase in ammunition expenditure, increasing sample size has a greater research payoff than increasing test reliability. As a result of the limits of increasing reliability of measurement by adding test items, the curve for increasing test length also plateaus much sooner that the curve for increasing sample size. Indeed, there is not much to be gained after test length is tripled. From Table E-1, 1000 additional rounds, which allows a test length of 30 tasks, decreases minimum detectable difference on Table VIII score 30 points, from 174 to 140. A further increase to 4000 rounds (four times 625) decreases minimum detectable difference only 12 more points.

Table E-1

Effects of Increasing Ammunition Resources on Minimum Detectable Differences in Table VIII Score by Adding New Tasks to the Existing Crews or by Adding New Crews to the Experiment

Input Values:

Persons per Cell = 12
Tasks/Person = 10
Number of cells = 2
Original within Cell Standard Deviation = 15.20
Original Standard Error of Mean = 4.388
Relative Reliability - Single task = 0.111; Ten tasks = .556
Absolute Reliability - Single task = 0.087; Ten tasks = .488

Intermediate Values:

Person Variance = 112.8
Item Variance = 284.2
Interaction Variance = 898.7

Resulting Minimum Detectable Differences:

Total		Revised	Minimum	Revised	Minimum
Rounds	Tasks	Tasks/Person	Diff.	Persons/Cell	Diff.
480	240	10	173.7	12	173.7
680	340	14.16	160.1	17	145.9
880	440	18.33	152.2	22	128.3
1080	540	22.5	147.0	27	115.8
1280	640	26.66	143.3	32	106.4
1480	740	30.83	140.5	37	98.96
1680	840	35	138.4	42	92.88
1880	940	39.16	136.6	47	87.80
2080	1040	43.33	135.3	52	83.47
2280	1140	47.5	134.1	57	79.73
2480	1240	51.66	133.1	62	76.44
2680	1340	55.83	132.3	67	73.54
2880	1440	60	131.5	72	70.94
3080	1540	64.16	130.9	77	68.59
3280	1640	68.33	130.3	82	66.47
3480	1740	72.5	129.8	87	64.53
3680	1840	76.66	129.4	92	62.75
3880	1940	80.83	129.0	97	61.12
4080	2040	85	128.6	102	59.60
4280	2140	89.16	128.3	107	58.19
4480	2240	93.33	128.0	112	56.88

Table E-2

Effects of Increasing Ammunition Resources on Minimum Detectable Differences in Table VIII Opening Time by Adding New Tasks to the Existing Crews or by Adding New Crews to the Experiment

Input Values:

Persons per Cell = 12
Tasks/Person = 10
Number of cells = 2
Original within Cell Standard Deviation = 3.583
Original Standard Error of Mean = 1.034
Relative Reliability - Single task = 0.062; Ten tasks = .401
Absolute Reliability - Single task = 0.058; Ten tasks = .383

Intermediate Values:

Person Variance = 4.923
Item Variance = 5.856
Interaction Variance = 73.36

Resulting Minimum Detectable Differences:

Total Rounds	Total Tasks	Revised Tasks/Person	Minimum Diff.	Revised Persons/Cell	Minimum Diff.
480	240	10	4.096	12	4.096
680	340	14.16	3.706	17	3.441
880	440	18.33	3.475	22	3.025
1080	540	22.5	3.321	27	2.731
1280	640	26.66	3.211	32	2.508
1480	740	30.83	3.128	37	2.333
1680	840	35	3.064	42	2.189
18[illegible]	940	39.16	3.012	47	2.070
2080	1040	43.33	2.970	52	1.968
2280	1140	47.5	2.934	57	1.879
2480	1240	51.66	2.904	62	1.802
2680	1340	55.83	2.878	67	1.733
2880	1440	60	2.856	72	1.672
3080	1540	64.16	2.836	77	1.617
3280	1640	68.33	2.819	82	1.567
3480	1740	72.5	2.803	87	1.521
3680	1840	76.66	2.789	92	1.479
3880	1940	80.83	2.777	97	1.440
4080	2040	85	2.765	102	1.405
4280	2140	89.16	2.755	107	1.371
4480	2240	93.33	2.746	112	1.340

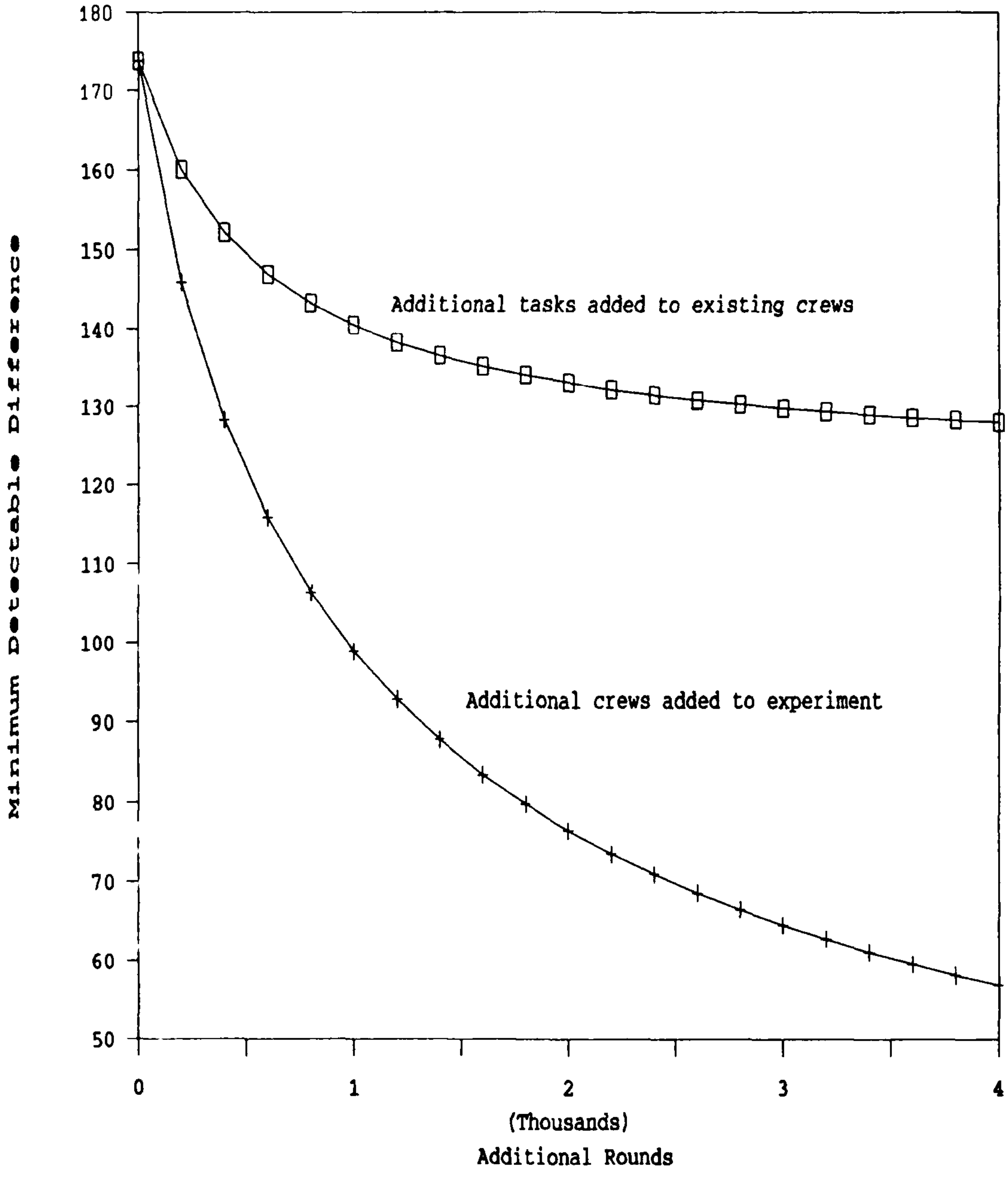


Figure E-1. The effects on minimum detectable difference on Table VIII score when additional ammunition is used to add crews to the experiment or to increase test length for existing crews.

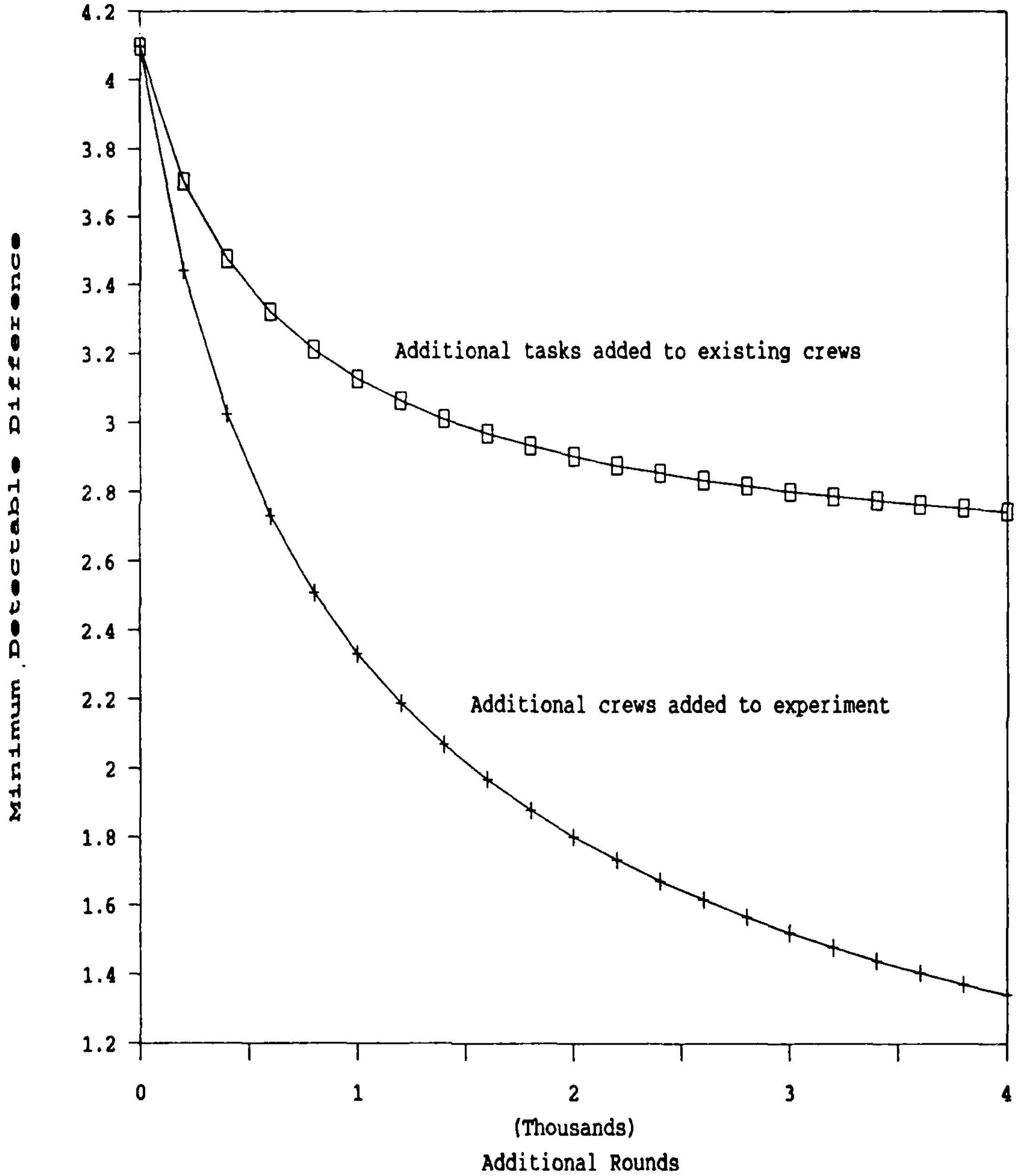


Figure E-2. The effects on minimum detectable difference on Table VIII average opening time when additional ammunition is used to add crews to the experiment or to increase test length for existing crews.

Extrapolating from the table, simply doubling the sample size without changing test length provides almost as much experimental power as an infinite increase in test length. That is, doubling sample size would give an MDD of 123 whereas the test length curve asymptotes with a reliability approaching 1.00 at an MDD of approximately 121.

Although less dramatic, similar comparisons hold for Table VIII average opening time. For example, doubling sample size reduces minimum detectable differences from 4.1 to 2.9 seconds. To achieve a similar reduction by increasing test length would require a four-fold increase in ammunition.

In summary, given a choice in which all other things are equal, adding crews is more desirable than increasing test length for gaining experimental power. The result that increasing sample size leads to greater reductions in minimum detectable differences generalizes to all cases except where test reliability is zero. In that case, the MDD reduction curves for increasing sample size and increasing test length coincide. That case is also trivial in that the variance for observed test measurements is all error with no true score variance. This can only occur when there are no true differences among persons so that all within cell variance is attributable to measurement error.

Application to Gunnery Test Matrix

Chapter 6 indicates that reliability with its associated effect on experimental power is not the only reason for increasing test length. A four-fold crew gunnery test was proposed to increase test content validity. The four parts of the test matrix are:

- A standard live fire Table VIII,
- An instrumented dry fire replication of Table VIII,
- A live-fire exercise against threat-based target arrays, and
- An instrumented dry-fire replication of threat-based target arrays.

Assuming that the instrumented dry fire segments are of similar length to Table VIII, this array of exercises would contain 40 tasks. Assuming that the dry-fire observations contribute as much reliability as additional live-fire observations, a 40 task test would decrease MDD from 173 to 136 points with little additional gain possible. Therefore, Table E-3 was developed to show the changes in MDD as a function of increased sample size given that the test length is set at 40 tasks.

There are also realistic scheduling constraints that may make the four-fold test strategy unfeasible. To accommodate this possibility, Table E-4 was developed to show decreases in MDD relate to sample size when the gunnery test consists of 20 tasks or double the observations of the standard Table VIII.

Table E-3

Effects of Increasing Sample Size on Minimum Detectable Differences in Score and Average Opening Time for a Four-Fold Expansion of Table VIII

Initial Sample Size and Number of Tasks:

------------------------- Table VIII Score Data -------------------------

Crew Variance = SPV = 112.8	Single Engagement	Total
Error Variance = SEV = 898.7	Rel. Reliab:0.111	Rel. Reliab:0.833
Item Variance = SIV = 284.2	Ab. Reliab: 0.087	Ab. Reliab: 0.537

Original within Cell Standard Deviation = 11.93
Original Standard Error of Mean = 3.444

---------------------- Table VIII Opening Time Data ------------------

Crew Variance = OPV = 4.932	Single Engagement	Total
Error Variance = OEV = 73.36	Rel. Reliab:0.062	Rel. Reliab:0.728
Item Variance = OIV = 5.856	Ab. Reliab: 0.058	Ab. Reliab: 0.397

Original within Cell Standard Deviation = 2.629
Original Standard Error of Mean = 3.444

Resulting Minimum Detectable Differences:

Additional		Score		Opening Time	
Rounds	Tasks	Revised Crews/Cell	Minimum Diff.	Revised Crews/Cell	Minimum Diff.
0	0	12	136.3	12	3.005
400	200	14.5	124.0	14.5	2.734
800	400	17	114.5	17	2.525
1200	600	19.5	106.9	19.5	2.357
1600	800	22	100.7	22	2.219
2000	1000	24.5	95.45	24.5	2.103
2400	1200	27	90.92	27	2.003
2800	1400	29.5	86.99	29.5	1.916
3200	1600	32	83.52	32	1.840
3600	1800	34.5	80.44	34.5	1.772
4000	2000	37	77.67	37	1.711
4400	2200	39.5	75.17	39.5	1.656
4800	2400	42	72.90	42	1.606
5200	2600	44.5	70.82	44.5	1.560
5600	2800	47	68.91	47	1.518
6000	3000	49.5	67.15	49.5	1.479

Table E-4

Effects of Increasing Sample Size on Minimum Detectable Differences in Score and Average Opening Time for a Two-Fold Expansion of Table VIII

Initial Sample Size and Number of Tasks:

------------------------- Table VIII Score Data ---------------------

Person Variance = SPV = 112.8	Single Engagement	Total
Error Variance = SEV = 898.7	Rel. Reliab:0.111	Rel. Reliab:0.715
Item Variance = SIV = 284.2	Ab. Reliab: 0.087	Ab. Reliab: 0.520

Original within Cell Standard Deviation = 13.11
Original Standard Error of Mean = 3.785

---------------------- Table VIII Opening Time Data ----------------

Person Variance = OPV = 4.932	Single Engagement	Total
Error Variance = OEV = 73.36	Rel. Reliab:0.062	Rel. Reliab:0.573
Item Variance = OIV = 5.856	Ab. Reliab: 0.058	Ab. Reliab: 0.392

Original within Cell Standard Deviation = 2.982
Original Standard Error of Mean = 3.785

Resulting Minimum Detectable Differences:

Additional		Score		Opening Time	
Rounds	Tasks	Revised Persons/Cell	Minimum Diff.	Revised Persons/Cell	Minimum Diff.
0	0	12	149.8	12	3.408
200	100	14.5	136.3	14.5	3.101
400	200	17	125.9	17	2.863
600	300	19.5	117.5	19.5	2.674
800	400	22	110.7	22	2.517
1000	500	24.5	104.9	24.5	2.385
1200	600	27	99.92	27	2.272
1400	700	29.5	95.59	29.5	2.174
1600	800	32	91.78	32	2.087
1800	900	34.5	88.40	34.5	2.010
2000	1000	37	85.36	37	1.941
2200	1100	39.5	82.61	39.5	1.878
2400	1200	42	80.12	42	1.822
2600	1300	44.5	77.83	44.5	1.770
2800	1400	47	75.73	47	1.722
3000	1500	49.5	73.80	49.5	1.678

Figures E-3 and E-4 were constructed to shows the combined effects of different test length and different sample size. These figures are useful for estimating sample size and test length requirements for given level of MDD. For example, assume that the researcher or research sponsor requires an MDD of 100 points.[1] Using a standard 10 task Table VIII, approximately 37 crews per cell would be required. On the other hand, a 20 task test would decrease sample size requirements to approximately 26 crews per cell, and a 40 task test would decrease sample size to approximately 22 crews per cell. The figures do not directly indicate total resource requirements; however, the Tables E-1 through E-4 can be consulted to cross reference ammunition requirement. Thus, for the example requirement of an MDD of 100 points, Table E-1 shows that a standard 10-task test with 37 crews per cell would require 1480 total rounds. Table E-3 shows that to detect an MDD of 100 points using a 40-task test would require 1600 "rounds," only half of which be actual ammunition.

[1]Hoffman (1988) indicates that because of the ceiling in the data he used, such a 100 point difference is not likely. On the other hand, the data provided by Campshure was apparently collected under much more rigorous conditions and the average Table VIII score was much lower. For this data, a 100 point difference may not be unrealistic.

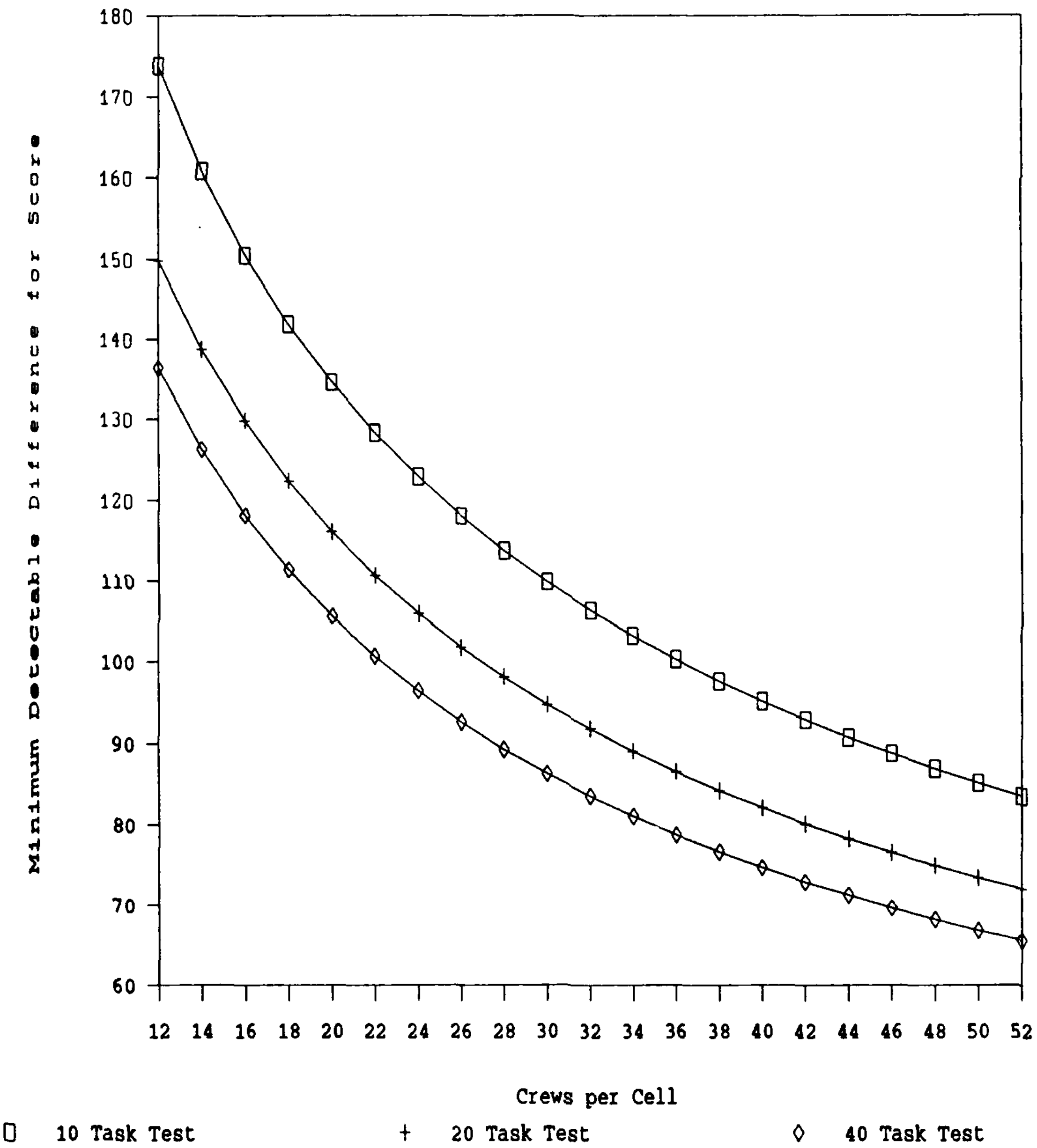


Figure E-2. Minimum detectable differences for Table VIII score for different combinations of test length and sample size.

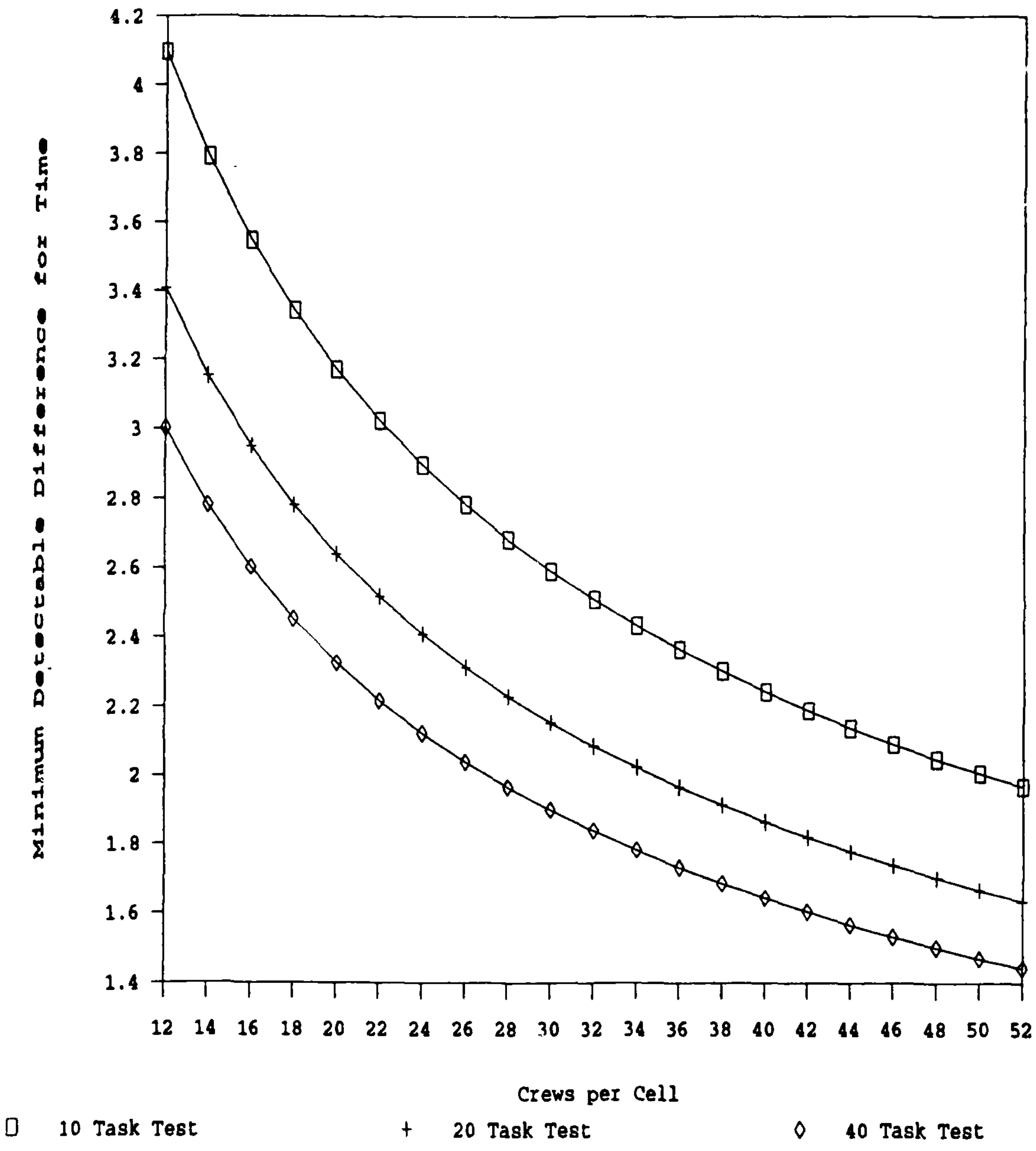


Figure E-4. Minimum detectable differences for Table VIII opening time for different combinations of test length and sample size.

Appendix F

Sample Scenario and Control Plans

CONTENTS

In the Inbriefing (Annex 3), unmodified text is to be read by the evaluator. Highlighted text relates action the evaluator should take.

Annex 1

Scenario

Upon platoon arrival in the tactical assembly area (TAA), the Pldr/PSG receives an inbriefing from the exercise OIC. The inbriefing provides an overview of the exercise situation up to the current2 point. The platoon is ordered to complete logistic preparation for the upcoming operation (rearm, refuel, maintenance).

Approximately 3 1/2 hrs before the exercise start time, the OIC issues a warning order over the Co/Tm net.

Approximately 3 hrs before the exercise start time, the Pldr/PSG reports for the OPORD. The OPORD is issued by the exercise OIC in the company of the "orders group" (role players). Prior to the exercise, the Pldr/PSG back-briefs the exercise OIC (Co/Tm CO), issues the platoon OPORD, and conducts rehearsals and pre-combat inspections.

Engagement 1. The platoon [RED] moves out at the specified SP time along the designated route to PP 3 (285448), through passage lane XEROX, and across the LD/LC. RED is acting as the lead platoon in a company team [BLACK] wedge formation. As RED attacks along AXIS RICK through CP 1 to CP 2, it encounters a series of 4 BMPs simulating elements of the threat security force. Targets are presented singly, and each remains up for 20 seconds. The second and third targets are accompanied by a set of troop targets, and presentation of targets 2 and 3 overlap. RED continues the attack to CP 2.

Engagement 2. RED continues to attack toward CP 4 overwatched by the remainder of the Co/Tm from vic. CP 2. As RED crosses PL MARY (vic. 260454), it is engaged by the first motorized rifle platoon (MRP) in a motorized rifle company (MRC) strong point. The other MRPs (MRC strongpoint) and a tank platoon (counterattack force) are presented in sequence as the platoon continues its attack.

Engagement 3. BLACK informs RED that the TF scout platoon has reported an MRB (-) moving south vic. 263474. BLACK has been ordered to occupy a blocking position north of CP 2 and orient north. RED is to withdraw to vic. CP 2, orient west, and cover the team's left flank. BLACK cannot overwatch RED's move. RED executes its withdrawal under pressure: four sets of targets are presented to represent elements of platoon to company (-) strength in the attack. The first set of targets is presented at a range of approximately 1700 meters from CP 4. Subsequent arrays close on CP 4 with the final set between CP 4 and CP 2. Target exposure times represent the amount of time the formation is exposed while crossing high ground and varies according to the distance notionally covered. Time between target engagements represents the time the notional threat formation uses to cross dead space. Throughout the engagement, radio traffic on Co/Tm net reflects the battle to the north.

Engagement 4. RED has completed its withdrawal to CP 2 under pressure. BLACK continues to defend on RED's right. The Co/Tm CO warns RED of a threat MRC moving south vic. 257463 and orders RED to continue to defend from CP 2. RED defends against a MRC reinforced with tanks. The array is presented for 40 seconds or until all targets are destroyed. Throughout this engagement, traffic on the Co/Tm net continues to reflect the battle to the north.

Engagement 5. The Co/Tm is still heavily engaged to the north. RED continues to defend from CP 2. Targets are presented in four sets: the first three in arrays representing continued pressure from the west. Each array remains up for 24 seconds. During the engagement, BLACK warns RED of a threat force breaking through behind RED and orders RED to reorient to the east. The final array represents the remnant of the MRC that breaks through BLACK. Upon completion of the engagement, BLACK 6 orders RED to withdraw through CP 1 to BP 51, orient west, and prepare to counterattack back to CP 4. The Co/Tm (-) consolidates its current position.

Engagement 6. RED has withdrawn to the original LD/LC. The Co/Tm (-) is preparing to resume the attack from current positions. RED is ordered to move to CP 2. BLACK cannot provide overwatch for RED. Co/Tm (-) will advance from east to west along the 46 grid and link up with RED at CP 4. After RED's lead section arrives at CP 1 and as the trail section is moving, RED is engaged by a MRC with tanks 300-500 meters from CP 1. Targets remain up 35-45 seconds. During the engagement, a sister tank platoon (notional) [WHITE] occupies firing positions north of the target array, and engages the right half of the target array. Selected targets in the northern half of the array are dropped, one at a time, to simulate WHITE's engagement. Once all targets are destroyed, RED resumes its movement to CP 2, with WHITE overwatching.

ENDEX is declared upon RED's arrival at CP 2.

Annex 2

Master Event List

ITEM NO	TIME/CUE	ACTION, EVENT, MESSAGE	REMARKS
1.	NA	Inbriefing	Upon platoon arrival in assembly area.
2.	E-3.5 Hr	WARNING ORDER	
3.	E-3 Hr	OPORD	Meet at TAA, move to BP 51.
4.	E-30 min	XO reports passage of lines coordinated.	
5.	E-20 min	Co/Tm SP time	Exercised plt is lead element.
ENGAGEMENT 1			
6.	E Hr	Co/Tm LD time--begin engagement 1.	Exercised plt is lead element. Start time (ST) 1.
7.	On contact	BLACK 6 orders action drill.	Upon contact report or observing contact v. target 1.1.
8.	CP 1	Targets 1.2, 1.3	10 Sec delay between target presentations.
9.	On contact	BLACK 6 orders action drill.	Upon contact report or observing contact v. targets 1.2 & 1.3.
10.	Enroute CP 2	BLACK 6 orders RED to occupy CP 2, continue attack on order.	
11.	CP 2	Target 1.4	
12.	Spot report re. tgt 1.4.	WHITE & GREEN (notional) report arrival CP 2, negative contact.	Engagement 1 complete.

ITEM NO	TIME/CUE	ACTION, EVENT, MESSAGE	REMARKS
ENGAGEMENT 2			
13.	When ready	BLACK 6 orders RED to move to CP 4, WHITE & GREEN (notional) to overwatch RED's move.	
14.	PL MARY	Target Set 2.1--begin engagement 2 timing.	ST 2
15.	On Contact	BLACK 6 orders contact drill.	On contact report or observing contact v. target set 2.1.
15a	Upon call for fire.	FIST acknowledges call for fire.	TRP 40 = 400 m N, 100 m W c/m tgt set 2.1.
16.	ST 2 + 15 Sec	Target Set 2.2.	
17.	On Contact	BLACK 6 orders WHITE to engage right half, GREEN to engage left half, RED to continue attack.	On contact report or observing contact v. target set 2.2. RED continues to engage both arrays on the move.
18.	RED crosses unimproved lateral road.	Target Set 2.3	Road vic. 255456
19.	On Contact	BLACK 6 orders WHITE to engage threat tanks, RED to continue attack.	On contact report or observing contact v. target set 2.3.
20.	RED crosses intermittent stream bed.	Target Set 2.4	Stream bed vic. 254457--RED cannot observe targets until reaching high ground vic. CP 4.
21.	Target Set 2.4 appears.	GREEN reports "CONTACT, TANKS AND BMPS, WEST--CANNOT ENGAGE--FIRES MASKED BY RED."	5-10 second delay between target presentation and GREEN's contact report.
22.	10-15 Sec later	BLACK 6 orders RED to engage TANKS and BMPs left of TRP 35, WHITE to move to CP 4 . . .	BLACK 6 cuts transmission short.
23.	15-20 Sec later.	BLACK 6 orders WHITE to stand fast at CP 2.	15-20 sec delay after item 22.

ITEM NO	TIME/CUE	ACTION, EVENT, MESSAGE	REMARKS
24.	Upon RED spot report	BLACK 6 acknowledges, orders "STAND BY FOR CHANGE OF MISSION."	Engagement 2 complete.
ENGAGEMENT 3			
25.	When ready	BLACK 6 transmits FRAGO 3.	
26.	10-15 Sec later	GREEN acknowledges FRAGO, reports "MOVING NOW."	
27.	3-5 Sec later	WHITE acknowledges FRAGO, reports "MOVING NOW."	
28.	Approx. 1 min later	WHITE reports "SET, NEGATIVE CONTACT."	
29.		BLACK 6 acknowledges.	
30.	15-20 Sec later	WHITE reports "CONTACT--TANKS AND BMPS--NORTH."	
31.		BLACK 6 acknowledges, orders WHITE to engage, orders FIST to get ARTY working, requests status of GREEN.	
32.		GREEN responds--will be in position in thirty seconds.	
33.		BLACK 6 orders GREEN to hurry, RED to begin his move.	
34.	First section crosses intermittent stream bed.	Target Set 3.1--begin engagement 3 timing.	Stream bed vic. 254457, enroute from CP 4 to CP 2. ST 3. Remaining target arrays for engagement 3 are time-sequenced. Messages (events 35-43) continue, concurrently.
34a.	ST 3 + 1 min	Target Set 3.2	

ITEM NO	TIME/CUE	ACTION, EVENT, MESSAGE	REMARKS
34b.	ST 3 + 2 min	Target Set 3.3	Or 15-20 sec after second section begins its move, whichever is later. ST 3.3.
34c.	ST 3.3 + 1:30	Target Set 3.4	
34d.	RED contact/ spot reports	BLACK 6 acknowledges, reminds RED he must hold.	If RED calls for FA/ mortar, FIST informs him--not available.
35.	Item # 33+1 min	GREEN reports "SET, ENGAGING."	
36.		BLACK 6 reports adjacent unit is engaging right half of the array. Orders GREEN to engage BMPs and WHITE to engage tanks then "Z-S-Us" and engineer equipment in left half.	
37.		GREEN & WHITE acknowledge.	
38.	Approx. 2 min later	GREEN reports reaching critical level on 25mm in ready ammo. Is rotating vehicles to hide positions to reload.	
39.	Approx. 20 sec later	WHITE reports also running short on ready ammo--WHITE 3 & 4 transferring ammo, 1 & 2 continuing to engage.	
40.	Approx. 1 min later	BLACK 6 reports emergency resupply will be available vic. BP 51 in fifteen minutes.	
41.	Approx. 1 min later	WHITE 3 reports new threat formation--about 15 tanks and BMPs vic. 257476, moving south.	

ITEM NO	TIME/CUE	ACTION, EVENT, MESSAGE	REMARKS
42.		BLACK 6 orders WHITE to continue current engagement, GREEN to engage new threat with TOW, FIST to shift arty fires onto new target.	
43.		GREEN & FIST acknowledge.	
44.	Approx. 1 min later	GREEN reports "FIVE ENEMY VEHICLES DESTROYED, VIC. 257464, REMAINING VEHICLES MOVING SOUTH INTO WOODLINE--CANNOT ENGAGE. REENGAGING TARGETS TO NORTH."	Engagement 3 complete.
ENGAGEMENT 4			RED is set at CP 2.
45.		BLACK 6 asks RED if he monitored GREEN's last SPOT report.	If RED monitored, proceed to item 47.
46.		BLACK 6 reports threat MRC moving south vic. 257463.	RED did not monitor GREEN's SPOT report.
47.		BLACK 6 orders RED to continue defending from CP 2.	
48.	Approx. 30 sec later	Target Set 4.0	
49.	On contact	BLACK 6 reminds RED that he must hold, WHITE and GREEN are still heavily engaged.	RED contact report v. target set 4.0.
50.	25-30 sec later	GREEN reports "6-10 BMPs MOVING INTO LOW GROUND VIC. 270470--CANNOT OBSERVE."	
51.		BLACK 6 directs FIST to cover the dead space with ARTY.	
52.		FIST acknowledges.	
53.		BLACK 6 asks RED for SITREP.	

ITEM NO	TIME/CUE	ACTION, EVENT, MESSAGE	REMARKS
54.	On RED's SPOT report	BLACK 6 directs RED to continue mission.	Engagement 4 complete.
ENGAGEMENT 5			
55.	15-20 Sec later	Target set 5.1--begin engagement 5 timing.	ST 5. Target sets 5.2-5.4 are time-sequenced. Items 56-59 run concurrently.
55a.	ST 5 + 1	Target set 5.2.	
55b.	ST 5 + 2	Target set 5.3.	
55c.	ST 5 + 3	Target set 5.4.	
56.	Approx. ST 5	GREEN reports "TANKS, BMPS AND TROOPS ASSAULTING THEIR POSITION FROM VIC. 269465."	
57.		BLACK 6 orders WHITE to engage across GREEN's front.	
58.		WHITE can only shift fires effectively with one section. Other section is engaging five tanks vic. 265465.	
59.		BLACK 6 acknowledges, informs GREEN he is moving into GREEN's area.	
60.	Approx. ST 5 + 1	BLACK 6 informs RED that a threat force is breaking through vic. 270460, orders RED to be prepared to orient east from current position and engage, on order.	
61.	On RED response	BLACK 6 acknowledges.	If RED indicates heavy engagement to west, use item 61a.
61a.		BLACK 6 indicates situation is critical, orders RED to move at least one section on order to avoid being cut off.	

ITEM NO	TIME/CUE	ACTION, EVENT, MESSAGE	REMARKS
62.	Approx. ST 5 + 2	BLACK 6 reports 6 enemy vehicles broken through, orders RED to reorient NOW.	
63.	1.5-3 min later	WHITE reports negative contact to north, requests orders.	
64.		BLACK 6 orders WHITE to leave one section to observe from current positions, other section to prepare to counterattack to north west on order. Orders FIST to screen the counterattack with smoke. GREEN to consolidate and reorganize in current position.	
65.		WHITE, GREEN acknowledge.	
66.	On RED SPOT report	BLACK 6 orders RED to move to H13 west .7 north .9, orient west, prepare to CATK to seize CP 4.	
67.	30 sec later	BLACK orders section/WHITE to CATK toward low ground X15 west 2.1 south 1.4 when FIST reports SPLASH.	
68.		WHITE acknowledges.	
69.	30 sec later	FIST reports SPLASH.	
70.		WHITE reports moving.	
71.	1 min later	WHITE reports "SET, NEGATIVE CONTACT."	
72.	15-30 sec later	GREEN reports consolidation complete, requests orders.	
73.	On RED report SET in new position	BLACK 6 orders the Co/Tm to stand by for a FRAGO.	Vic. 273449--Engagement 5 complete.

ITEM NO	TIME/CUE	ACTION, EVENT, MESSAGE	REMARKS
ENGAGEMENT 6			
74.	When ready	Issue FRAGO 6.	
75.		All elements acknowledge.	
76.		BLACK 6 orders RED, GREEN, WHITE (-) to move NOW.	RED moves to CP 1 by bounding overwatch.
77.	Lead section arrives CP 1		If lead section fails to stop at CP 1, execute target set 6.0 immediately (ST 6), go to item 79.
78.	30-45 sec delay after item 77	Target Set 6.0--begin engagement 6 timing.	ST 6.
79.	On contact	WHITE reports he sees RED, will be in position to engage in 20 secs.	Upon contact report or observing contact v. target set 6.0.
80.		BLACK 6 orders WHITE to assist RED, WHITE engage northern half, RED engage southern half.	
81.	ST 6 + 0:25	WHITE reports, "SET, ENGAGING NORTHERN HALF."	RED shifts fires to southern half.
82.	On SPOT report	BLACK 6 orders RED to move to CP 2, WHITE to cover his move.	
83.		WHITE acknowledges.	
84.	On RED report SET at CP 2	Engagement 6 complete, ENDEX.	RED moves to TAA for recovery and AAR.

Annex 3

Inbriefing

CONDITIONS: The platoon has occupied the tactical assembly area and is preparing for the exercise. The platoon leader and platoon sergeant report for their inbriefing. The inbriefing is presented via face-to-face contact. The defensive overlay is posted to the operations map. The Pldr/PSG are shown the overlay from the defensive mission.

LT/SGT ________, thank you for coming. My name is _________. I'll be acting as your company commander during this test. First, I'd like to make sure I have your unit designation correct. You are the platoon leader for ______, correct? [Wait for Pldr/PSG to respond.]

Good. During the next ____ hours, your tank platoon will take part in a platoon gunnery test using the PRIME facility with instrumented MILES, TSV, and several other training devices. Have you been on Phantom Run before? [Wait for Pldr/PSG to respond. You make necessary responses to his comments.]

Let me assure you that the purpose of this test is **not** to help your battalion commander find a good reason to make you the support platoon leader. We are in the process of testing a program, not you. This program is an attempt to develop a realistic, threat-based, tactical platoon gunnery model. This is **not** a Table XII and will not be scored like a Table XII. There will be evaluators, and they will be using an evaluation model based, in part, on the platoon MTP and Table XII. However, the evaluation model is very different from anything you've seen before. Don't worry about that. Just do your very best. I want you to act just as you expect to in combat using the training devices, of course, to simulate live ammunition.

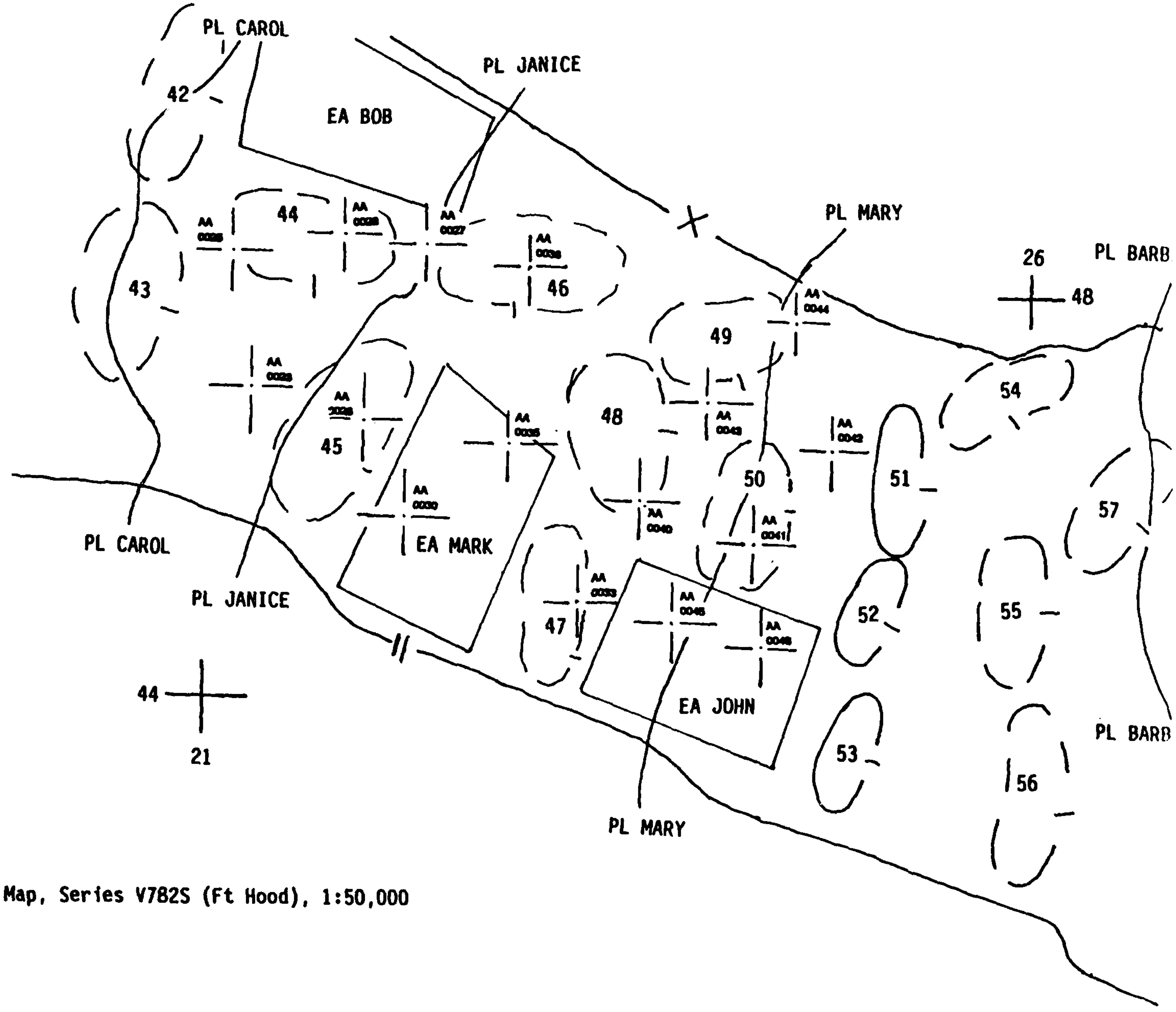
What are your questions about the purpose of this exercise? [Answer the Pldr/PSG's questions.]

All right, here's the scenario. The war started yesterday with the RED FORCE attacking from west to east north of Killeen. Your brigade is the southern brigade in the divisional sector. The enemy's main effort was to the north, and your brigade held its ground pretty well. Your company team was part of a mech-heavy task force that was involved in moderate fighting yesterday. After about four hours of heavy fighting, the division commander prepared to commit his reserve and warned your brigade commander to be prepared to withdraw a task force minus to reconstitute the divisional reserve. The mech battalion that you were attached to was chopped from the brigade about four hours ago. Your company team was detached from the mech battalion back to your parent battalion. Your company team was pulled back to an assembly area to rearm and refuel. Until you reenter the line, the company team is technically the brigade reserve, but it is reporting directly to your regular battalion task force headquarters.

The company team consists of your platoon, another tank platoon, a mechanized infantry platoon, the FIST, a maintenance section, and your regular company headquarters. The team is currently located in the assembly area. The current overlay is as shown here (indicate map). Your last instructions were to complete your LOGPAC, report when complete, and be prepared to move to, occupy, and defend BP 52 here (point). BP 52 is a company size position. The company commander has not indicated how the force will be deployed, but you were on the left of the original battle position and the mech platoon was to your right.

The company commander went to the battalion task force TOC. He said he expected to be back 30 minutes from now. I need to verify your call sign and frequencies and make sure we are using your regular SOP. [Gather/verify data.]

What are your questions? [Answer questions and release Pldr/PSG.]



Map, Series V782S (Ft Hood), 1:50,000

Warning Order

CONDITIONS: The platoon is preparing for combat operations in the assembly area. The company commander is enroute back from a battalion task force operations order. The following is issued on secure radio at H-3.5 hrs.

________ [insert the NET CALL SIGN]. THIS IS ______ [insert the CO's call sign], WARNING ORDER, OVER.

[Allow stations to respond.]

________ [insert NET CALL SIGN] CONDUCTS FORWARD PASSAGE OF LINES AND MOVEMENT TO CONTACT AT _____ [insert exercise start time (E HOUR)]. SIERRA PAPA AT _____ [insert E-20 min]. ORDERS GROUP AT CHARLIE PAPA AT _____ [insert E-3 HRS], OVER.

[Allow stations to respond.]

COMPLETE LOGPAC NO LATER THAN _____ [insert E-3 HRS]. REPORT WHEN COMPLETE, OVER.

[Allow stations to respond.]

ROGER OUT.

Operations Order

CONDITIONS: The platoon is still in the assembly area preparing for combat operations. The company commander is preparing to give his team operations order. The order is issued in person. A map with the attack overlay is posted in the company command track. The XO, 1SG, FIST officer, and other platoon leaders are present. Wheeled vehicles are available to transport the orders group to a terrain vantage point.

[Throughout the operations order, the other company teams in the battalion task force are referred to as Tm ___ [a], [b], or [c], respectively. If the tested platoon is organic to company D, use teams a-c as written. If the tested platoon is organic to company A, substitute Team D wherever Team ___[a] appears, and so on. Substitute the tested platoon's numerical designation (e.g., 1st) wherever "___[test]" appears, and a different numerical designation (e.g., 2nd) wherever "___[other]" appears.]

[Upon platoon leader's arrival, show him the map and direct him to copy the overlay. Advise him that once everyone is ready the group will make a leader's recon. [When everyone is assembled, direct them to mount in wheeled vehicles, move to vicinity grid 276449, dismount, and gather group.]

Okay is everyone here? [Wait for response.] Good. Let's do it.

There will be no change in our task organization.

SITUATION: Enemy:

The enemy has spent the last six to eight hours consolidating his gains to the north and west. We saw only moderate to light action in the brigade sector while the main effort was apparently to our north.

Okay, we're going to go up to the crest now, and I'm going to try to point out some of the key terrain and enemy positions. Stay low and pay attention.

[Lead group to overlook up slope on foot to vantage point overlooking PHANTOM RUN, vicinity 274448.]

First, I want to orient you. We have just come up ROUTE XEROX and are currently in BP 51 where TEAM ___ [c] is defending. Everyone see that saddle about 1400 meters away (point)? That is checkpoint two. T-R-P four one -- that's target alpha-alpha zero-zero-four-one on the overlay -- is that finger to the right of checkpoint two. Now, this side of checkpoint two, about 700 meters away, see where the trail cuts through the trees on that rise (point)? That's checkpoint one. Castle rock is about five kilometers away--it's the steep mountain way out there (point). Everyone see it? Okay, that's T-R-P two-eight, and it is the left half of OBJECTIVE CHEETAH. If you remember that airfield south of CASTLE ROCK, the northwest side of the airfield is OBJECTIVE WILDCAT. AXIS RICK runs from here straight to the objective centered on checkpoints one and two. OBJECTIVE TIGER is about four kilometers beyond CHEETAH.

We will be facing remnants of a motorized rifle battalion. There are several known enemy positions--platoon and smaller--about there (point) and

there (point). These are on the overlay here and here (indicate on map). There is another position here (point to third position on map), but we can't see it from here. The infantry has been seen digging in, and the BMP's are in semi-dug in positions. The S-2 figures that there are four to six T-80 tanks probably consolidated as a reserve or counter attack force somewhere near Castle Rock. The platoon positions I've pointed out are probably their security belt. They'll probably take us under fire then use artillery on us to cover their withdrawal. We'll probably encounter company strong points further west with obstacle systems and planned engagement areas.

The enemy enjoyed better success up north, so the S-2 thinks that the second echelon will be committed there. However, the enemy may recognize that the defense is weaker here and try to test us in this sector. We may see some second echelon forces in our area. If so, the rolling terrain along the southern portion of the sector is a probable avenue of approach. In other words, we could run head-on into an enemy formation, or they may be further to our south between our axis and Killeen.

One more thing: the enemy has not used chemicals, yet. But he may do so without much warning, especially if the weather is favorable.

Weather:

The weather for the operation will be ________ [fill in current weather report]. Trafficability will be _______ [fill in], and visibility will be ______ [fill in]. This weather is ________ [specify: favorable/unfavorable] for chemical weapons and smoke operations.

Friendly:

The task force mission is to attack from current positions toward OBJECTIVE TIGER, here (point to objective on map), and assume a blocking position oriented generally to the west. On order, the task force will continue the attack to the north. The task force commander wants to uproot the enemy's forward elements making it possible for the rest of the brigade to counterattack to the north along AXIS GLYNN. The critical event is penetrating the enemy's forward defenses and gaining control of the high ground in OBJECTIVE TIGER. The brigade will follow our penetration into enemy territory then turn north to try to attack into the flank of the enemy's second echelon just as they deploy. The task force will follow the rest of the brigade once they pass through.

Team _____ [a] will attack on our left along AXIS BOB to seize OBJECTIVE WILDCAT. They will be followed by Team _____ [b] which will continue the attack on OBJECTIVE TIGER.

The TF scout platoon will be to our right screening the task force right flank from the LD/LC.

Team _____ [c] will assist our forward passage of lines and support our initial attack by fire. Then they will follow us along AXIS RICK and continue the attack to OBJECTIVE TIGER.

If we run into strong resistance that we can't handle, the trail elements of the task force will circle around--probably to the south--and attempt to outflank the enemy force.

The ______ [insert designation of Div Cav Sqdn] will screen the brigade's left flank as the brigade attacks out of its current positions. The CAV will come up behind us and establish OP's on OBJECTIVES CHEETAH, WILDCAT, and TIGER enabling the task force to follow the remainder of the Brigade.

The mortars are G-S to the task force with priority of fires to Team ____ [a] in the south. They are currently located at 281456, and will generally follow behind us on AXIS RICK.

_____ [insert designation of the Bde's normal DS FA Bn] is D-S to brigade with priority of fires to our task force initially. We have priority of fires for F-A within the task force.

There is a composite engineer platoon D-S to the battalion that will help us assault across or through any obstacles. There is one intermittent stream that we have to cross just south of checkpoint four. We may need their A-V-L-Bs to cross that stream. They'll move with us initially, prepared to assist that crossing if necessary.

A-D-A. The brigade is holding dedicated air defense units--VULCAN, STINGER, and CHAPPARRAL--in a G-S role. They'll probably be following us up the task force zone, but we probably won't see them until we get to CHEETAH. If they get in our area, we'll try to work directly with them for mutual support--more on that later.

CLOSE AIR SUPPORT and ARMY AVIATION:

The brigade has air support allocated, and we expect attack helicopters supporting the follow-on mission when the brigade continues the attack. We may see a couple sorties of fixed wing during our initial attack, but we have no direct control of them.

MISSION:

Our MISSION is to attack through Team _____ [c] along AXIS BOB to seize OBJECTIVE CHEETAH at _____ [E-Hour]. Upon reaching OBJECTIVE CHEETAH, we will support the task force's attack on OBJECTIVE TIGER by fire then continue the attack along AXIS DAVE on order.

EXECUTION: Intent:

I want to overrun and destroy the enemy security forces in these forward positions (point to first set of enemy positions on map) before they can withdraw and reinforce the strongpoints in the second belt. I want to continue our momentum and take this strongpoint (indicate enemy position on near side of OBJECTIVE CHEETAH) from its flank avoiding the enemy's fire sack and obstacle system.

Concept of Operation:

Maneuver: (refer to execution matrix)

LD/LC to checkpoint one: We'll pass through Team _____ [c] without stopping and immediately deploy into a team wedge with _____ [test] platoon on the point, mech on the left, and ____ [other] platoon on the right guiding directly on checkpoint one. I want ____ [other] platoon to speed up when we get near checkpoint one, and the other two platoons to slow down before we go into the trees. Sweep through the tree line to the far side. Then I want the company team less ____ [test] platoon to stop at the far side of the tree line and overwatch ____ [test] platoon's bound. ____ [test] platoon, I want you to keep moving through the trees and continue to checkpoint two.

If we meet any significant resistance vicinity checkpoint one, I want the tanks to take up firing positions and cover the infantry. The infantry will move up and sweep the tree line from south to north and clear the enemy out of there. Stay mounted as long as possible. As soon as possible, I want the tanks to move to the far side of the tree line until the mech is mounted again and ready to move on.

Any questions so far? [Answer any questions.]

Okay, from checkpoint one, the team minus covers the ____ [test] platoon. As soon as they clear the stream bed, here (point), if the enemy hasn't engaged them, I want the trail elements to move out in a wedge so that we don't lose our momentum. ____ [test] platoon, I want you to go right into the saddle, deploy on line, and hold up briefly. Mech, as you clear the stream bed, I want you to swing behind the tanks into echelon right and orient on this finger (point at map) to the right of the saddle. ____ [other] platoon, you take the knob to the left of the saddle. Again, if the enemy doesn't slow us down, I want to continue the attack as soon as the trail platoons catch up.

If we are engaged as we move to checkpoint two, the overwatch platoons will take the enemy under fire, and the bounding platoon will conduct an action drill. I want the tanks to overrun the enemy positions then the mech to move up right behind them. ____ [test] platoon, you keep moving to the forward slope of the ridge then stop and block any counterattack. Mech, move up on the enemy position if you can and dismount right on top of them. _____ [other] platoon, move with the mech unless there is a threat on the assault force's flank. If there is a flank threat, keep it pinned down until I give you further orders.

If the enemy has any significant A-T capability in those positions, I want the lead element to get as close as it can, take up good firing positions, and support a dismounted assault.

From checkpoint two, we'll repeat the same procedure guiding on checkpoint four: ____ [test] platoon in the lead. The trail element will move in echelon right. At checkpoint four, I want ____ [test] platoon to orient on T-R-P three-five while the trail platoons move up.

When everyone is together again, I want the ____ [other] platoon to take the lead guiding on checkpoint three. I want the mech to remain in overwatch with ____ [test] platoon. When the lead platoon gets about 500 meters past you, if they have not taken any fire, the trail section moves out in a wedge maintaining effective overwatch as you move.

At checkpoint three I want ____ [test] platoon on the left, ____ [other] platoon in the center, and mech platoon on the right. ____ [test] platoon, you will cover the other two platoons as they assault OBJECTIVE CHEETAH. As _____ [test] platoon gets set, I want the ____ [other] platoon moving to maintain momentum. Move out on line for the assault with the mech platoon also in a platoon line behind the tanks. Guide from checkpoint three to twelve. _____ [other] platoon, you take up positions vicinity checkpoint twelve orient from T-R-P two-three to T-R-P two-seven. Mech, you sweep the front side of the objective from right to left then take up positions on Castle Rock oriented from T-R-P two-three to T-R-P two-five. Overwatch, when I give you the word, you come up and take the center of the objective and orient from T-R-P TWO-THREE to T-R-P two six. ____ [other], when the others get set, you shift to the right from T-R-P two-five TO T-R-P three-eight.

We'll worry over the details of the rest of the task force attack once we consolidate CHEETAH.

Fires: As I said before, we have priority of fires for F-A initially. We also have one priority target allocated throughout the battalion's attack. There is a schedule of fires that the FIST can brief you on after this. Basically, there will be a prep that begins about 10 minutes before we are scheduled to cross the L-D. The last part of the prep will be on that ridge line (point to checkpoint two). As we close on the ridge line, the FIST will shift fires to another target group vicinity checkpoint four. From that point, fires will be on call until we are prepared to assault CHEETAH at which time there will be a prep of CHEETAH. The priority targets will be the three T-R-Ps along AXIS RICK and on the objective shifting from one to the other as we move. Once we consolidate CHEETAH, the priority target will be T-R-P two-five. As the rest of the task force begins to pass through, we'll shift the priority target to one of the T-R-Ps to the north--probably two-six.

Specific instructions: [Refer to execution matrix.]

Air Defense: The air defense weapons status is tight. Fire only at targets positively identified as hostile. I don't want to waste any ammo on enemy aircraft unless they attack us or a nearby unit. In other words, use passive air defense. If guns or stingers show up in our position, I want the X-O to get with them and make sure we're linked up and wired in. If they show up on your platoon position and the X-O can't get to you, I want platoon leaders to make the liaison. Unless you're too busy fighting the enemy, of course.

Obstacles, Mines, Fortifications:

There are some friendly obstacles in our zone of action, but they are all situated in positions that should support us more than the enemy. The S-2 said that most of those would have been reduced or marked by the enemy's mobile obstacle teams and should not be a factor. The enemy will probably have put in mines and wire to canalize us into the fire sack, here (point), and delay us in their engagement area. That's why we want to try to hit the strongpoint in the flank--to avoid the obstacle.

The stream bed approaching checkpoint four is a potential natural obstacle. We want to eyeball it before we expose ourselves, and if we need help, we'll call up the AVLB. ____ [other] platoon, you'll be the support force; ____ [test] platoon, you'll be the breach force; and mech, you'll be the assault force.

Coordinating Instructions:

X-O move with the trail platoon at all times.

TOP, locate and move with the company combat trains to an attack position right there (point to area on east slope of current position within BP 51). Bound up to checkpoint two when we begin the second bound then stay one terrain feature behind the maneuver force. Move to the rear of OBJECTIVE CHEETAH on order.

FIST, stay with me.

MOPP level: We will stay in MOPP level one until we prepare to move out then go to MOPP 2: suits and boots on; carry gloves and masks. If it ____ ____ [specify: "stays warm" or "warms up"], we'll wear the garment open, but if the enemy employs gas or if we get a warning that its use is imminent, we'll close them up.

O-E-G rate: Negligible risk to unwarned, exposed personnel.

P-I-R: Report the following, immediately:
Any enemy force of more than three vehicles moving together.
Any enemy defensive position containing six or more vehicles.
Any enemy wearing protective gear.
Any enemy special purpose engineer vehicles.
Any enemy air defense weapons systems.

Tanks: Battlecarry is SABOT, 1200 meters. Our most dangerous threat is the tank counterattack force. Besides, SABOT is effective against the other likely targets, BMPs and bunkers, and it's more accurate than HEAT.

Target engagement priorities: Air defense systems and special purpose engineer vehicles.

Priority of engagement: Tanks on tanks, then BMPs, then other vehicles. Bradleys--25 millimeter on BMP's and helicopters, then other vehicles. Everyone use automatic weapons primarily to suppress enemy defenses--dug-in troops. Tanks: If you acquire a bunker, fire your battlecarry round then follow up with one round HEAT.

I do not intend to conduct a team-level rehearsal. I want you to get back to your platoons and spend the time getting them ready. However, I do want a back-brief from each of you, and I would like to view your rehearsals. ____ [test] platoon, I'll want a back-brief from you in ____ minutes; then I'll come to you, mech. X-O, I want you to receive the back-brief from the ____ [other] platoon. Plan on issuing your orders after you brief me or the X-O, and do your rehearsals during or right after your OPORDs.

One other thing--we are supposed to remain abreast of Team _____ [a], attacking along AXIS BOB. I want the X-O to keep track of their progress and tell me if we need to speed up or slow down. I really don't want to slow down, but we'll hold at one of the terrain features, if necessary.

SERVICE SUPPORT

General:

Company hard trains currently in the AA will move with the team along ROUTE XEROX to the attack position then bound up behind the team to checkpoint two, then four, then three, and then to the rear of OBJECTIVE CHEETAH.

Company field trains located with the task force field trains.

Task force combat trains 298451, field trains 351479.

Material and Services:

Class I: Make sure you have three days' supply of MREs on board each vehicle. We should have hot A's for _________ [specify meal] before we move. We'll be on C's during the operation, and task force expects to feed B's tomorrow evening. Afterward, ration cycle should be C-C-A.

Class III: Everyone should have topped off already. Any shortfalls? [Wait for response.] Make sure you have your basic load of packaged products on board. Have your platoon sergeants get with TOP if they need anything else. Task force expects to refuel us at OBJECTIVE TIGER when we consolidate there. If necessary, we can request an emergency resupply at CHEETAH.

Class V: Is everyone up on ammo as well? [Wait for response. If anyone says "no," direct 1SG to ensure the LOGPAC is completed ASAP.] Same as Class III--resupply on TIGER or emergency resupply on CHEETAH. TOP, I expect we'll use BOO-KOO seven-six-two and caliber fifty. See how much you can weasel out of the S-4 and cram into the maintenance track. Plan on bringing that up to us at CHEETAH or earlier if we need it.

K-I-A: Mech, Evac any dismounted K-I-A to the last checkpoint for the first sergeant to pick up. Everybody, if you lose a victor, just leave the K-I-A with it for the trains. If you lose a man on an operational vehicle, carry the body with you to the next checkpoint along the trains' axis of displacement.

Maintenance: The task force has a UMCP at passage point three and will establish another vicinity 237456 at that corner just south of Airfield Lake when WILDCAT and CHEETAH are secured.

Medevac and Hospitalization:

W-I-A: Platoons, Evac your wounded to the nearest checkpoint along the trains' route. Try to avoid diverting too much combat power for litter-bearers. If possible, keep your wounded aboard combat vehicles and carry them forward with you to the next checkpoint. Let TOP know that you have wounded, and he'll get the medics forward to treat and evacuate them.

The task force aid station will be with the task force Combat trains.

Personnel: S-O-P.

Civil-Military Cooperation: There is a curfew for civilian personnel from 2100 to 0600 daily. Treat violators as E-P-W.

Miscellaneous:

COMMAND AND SIGNAL:

Command:

Co Cdr will move with the lead tank platoon.

XO will move with the trail tank platoon.

TF TOC is at 313435. Jump is at 288438. Axis of displacement is along AXIS RICK. TOC will advance no further than checkpoint four. Jump will probably go to vicinity checkpoint 14 when TIGER is seized.

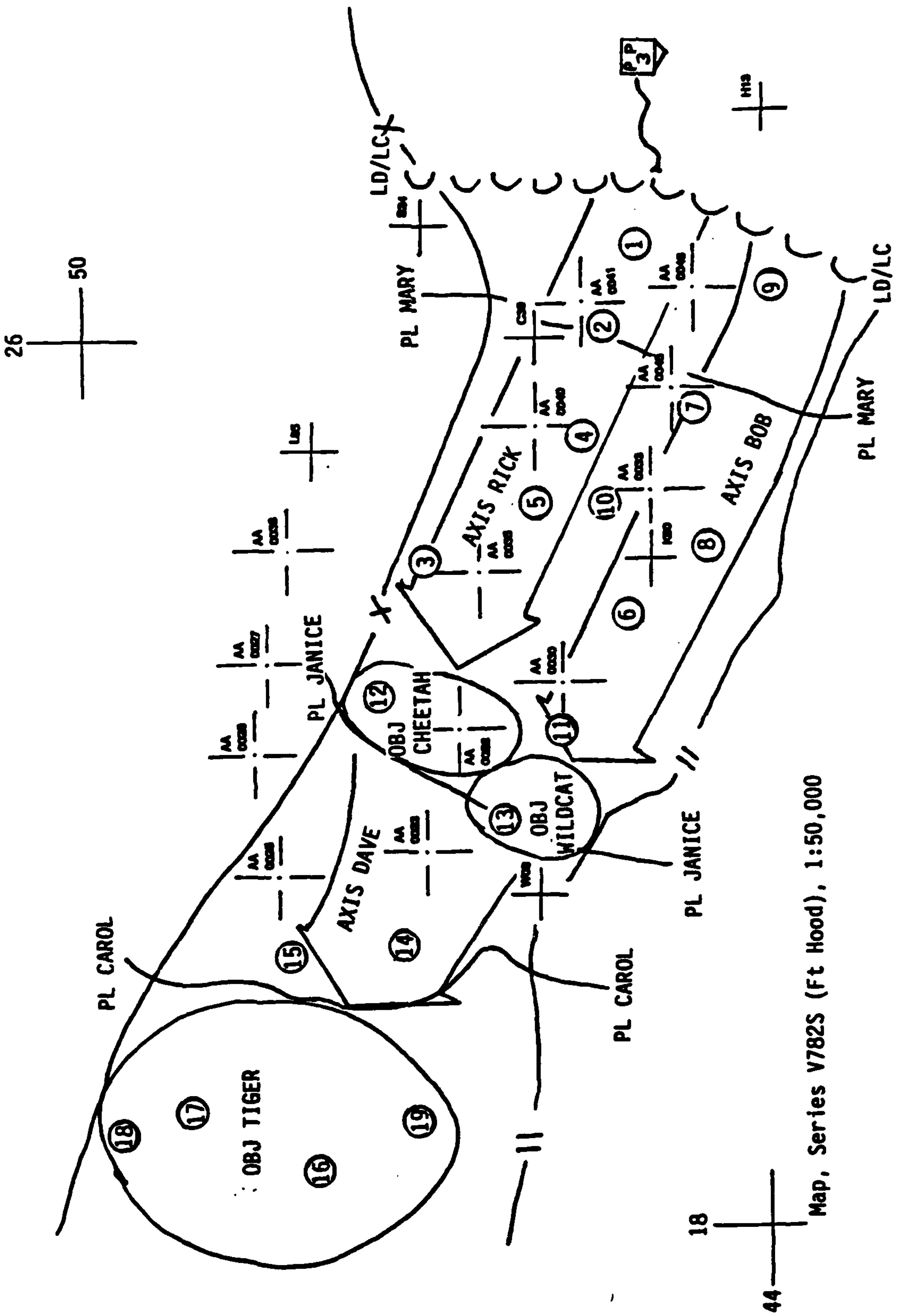
TF commander will move with Team _____ [c] initially, then will probably join us vicinity checkpoint four.

Succession of command:
Task force: C-O, X-O, S-3, then Team C commander.
Company: C-O, X-O, ____ [test] platoon leader, mech, ____ [other] platoon leader, then FIST.

Signal. [Provide current data.]

NOTE: FOR THE UPCOMING SCENARIO, THE EXERCISED PLATOON WILL BE REFERRED TO AS "RED," THE OTHER TANK PLATOON AS "WHITE," THE MECH PLATOON AS "GREEN," and the CO/TM HEADQUARTERS AS "BLACK." IF IT IS NECESSARY TO MODIFY REFERENCES, DO SO PRIOR TO THE BEGINNING OF THE EXERCISE TO REDUCE CONFUSION DURING THE SCENARIO.

Time now is ______ [current local time].



Map, Series V782S (Ft Hood), 1:50,000

Training only
CLASSIFICATION

DATE/TIME

TASK ORGANIZATION (changes only): None

MISSION: Attack through TM[C] along AXIS BOB to seize OBJ CHEETAH at [E-Hr]. Attack threat forces east of OBJ CHEETAH by fire, support Task Force attack on OBJ TIGER.

COMMANDER'S INTENT: Overrun enemy security forces in zone. Attack posns on CHEETAH from the flank, avoid obstacles & Threat fire sacks.

UNITS / EVENTS	CO TM	FSO ENGR	1ST PLT	2ND PLT	3RD PLT	HARD TRAINS	OTHER
MOVE TO LD/LC / FORM ORDER	RTE XEROX - PP3 / CO COLUMN	Move w/ CO	LEAD	THIRD	SECOND	RTE XEROX TO BACK SIDE BP 51 / TRAIL	XO coord Passage
MOVE TO TECH / FORM	TRAVEL - CP1 / TM WEDGE	Pri Tgt: TRP 41	CP 1 / POINT	CP1 (N) / RIGHT	CP 1(S) / LEFT	BP 51(E)	
MOVE TO TECH / FORM	BOW - CP 2, 4 / CP 1-2: WEDGE CP 2-4: ECH-RIGHT	Pri Tgt: TRP 4Ø, then 35	CP 2, 4 o/w CO TM (-) / LEAD	CP 2(S), 4(N) (TRAIL) / CP 1-2: R/S (wedge) CP 2-4 Lead (Ech)	CP 2(N), 4(N) (TRAIL) / CP 1-2 L/S WEDGE CP 2-4 TRL IN ECH	Move -CP2 when (o(-) moves CP 2-4	
MOVE TO TECH / FORM	TOW - CP 3 / Extended WEDGE	Pri Tgt: TRP 28	OW THEN CP 3(S) / FROM CP4 LEFT	CP 3 / Lead	Move to CP 3(N) / RIGHT	Move TO CP4 when o/w moves To CP 3	
ASSAULT / FORM/ POSN	OBJ CHEETAH / CO COL PLTS ON LINE	PREP CHEETAH Shift 500 NW	ATTK BY FIRE / CP3(S), TRAIL	CP12 / Lead	FRONT OF CHEETAH N-S / Second	Move TO CP 3	
CONSOLI-DATE / ORIENT	OBJ CHEETAH / TRP 23-38	Pri Tgt: TRP 25	10-2 / TRP 23-26	2-6 / TRP 23-27 THEN TRP 25-38	6-10 / TRP 23-25	Move to Cheetah O/O	
CALL SIGN / FREQ							

MOPP LEVEL	CDR WITH	FA CALL SIGN	MORTAR C/S	CO FLD TRAINS LOC	EMERGENCY SIGNALS
I til E-30min then II	1st to CP2 then 2d to OBJ			351479	
RES Ø c Gy	ADA STATUS TIGHT	FREQ	FREQ		

OTHER INFORMATION:
(code words)
(priority for resupply)

GRAPHIC CONTROL MEASURES: PHANTOM RUN

CHECKPOINTS

Number	Description	Location
1	TRAIL CUT THROUGH TREELINE	PK268452
2	SADDLE	261454
3	FINGER	240470
4	RIDGE LINE	251456
5	RIDGE LINE	245460
12	HILL TOP	228474
PP 3	ROAD JCT	285448

TARGETS

AA0028	HILLTOP	225467
AA0035	SUSPECTED MRC DEF POSN	239465
AA0040	SUSPECTED MRP DEF POSN	252457
AA0041	SUSPECTED MRP DEF POSN	263456

TIRS REFERENCE POINTS

TIR	GRID
C39	2646
F71	2347
H13	2844
K90	2445
L85	2548
S24	2747
W03	2146
X15	2948

OBJ CHEETAH: 1200 meters wide by 800 meters deep, center of mass: 227469. Long axis grid azimuth 22°.

LINEAR CONTROL MEASURES

BRIGADE BOUNDARY (Task Force Northern boundary): North side of improved road from PK280473 to 260464 to 229475 then west-by-northwest to north slope of Black Mountain, vic. 213480 . . .

AXIS RICK: 1200 meter axis, center line crosses LD/LC at 273450, runs west by northwest to OBJ CHEETAH.

LD/LC: Generally along ridge line (forward slope) from vic. 273469 to 284460 to 281440 to 269428.

PHASE LINE MARY: 263470 to 263466 to 262460 to 254440.

PHASE LINE JANICE: 230480 to 229478 to 228471 to 220467.

ROUTE XEROX: From RJ at 284450 along unimproved road to 276449, then along tree line to RP at 275449.

FRAGO 3

CONDITIONS: RED is at CP 4. The remainder of the Co/Tm (notional) is at CP 2. Engagement 2 is complete. The task force scouts (notional) have observed a large threat formation to the north. The task force attack has been suspended. The Co/Tm has been ordered to assume a blocking position north of CP 2 and to orient north.

BLACK, THIS IS BLACK 6 CHANGE OF MISSION, OVER:

[Allow all stations to respond.]

SCOUTS REPORT THREAT M-R-B 263474 MOVING SOUTH.

MISSION: BLACK DEFENDS FROM 59: FROM SIERRA 24 WEST POINT 4, SOUTH POINT 8.

GREEN AND WHITE MOVE NOW: WHITE ON LEFT, GREEN ON RIGHT. ORIENT NORTH. GREEN ESTABLISH VISUAL CONTACT WITH BLUE ON YOUR RIGHT.

RED, COVER OUR MOVE. WITHDRAW TO 2 ON ORDER, ORIENT WEST.

FIST, PRIORITY OF FIRES TO WHITE UNTIL GREEN IS IN POSITION THEN TO GREEN.

ACKNOWLEDGE, OVER.

[Allow all stations to respond.]

FRAGO 6

CONDITIONS: RED has moved back to positions vicinity the original LD/LC. The remainder of the Co/Tm (notional) is still in positions north of CP 2. The threat second echelon attack has been defeated. Engagement 5 is complete. The task force is resuming the attack from current positions.

BLACK, THIS IS BLACK 6, CHANGE OF MISSION, OVER.

[Allow all stations to respond.]

THREAT SECOND ECHELON REGIMENT DEFEATED. THREAT CANNOT CONTINUE THEIR ATTACK: ARE ESTABLISHING A HASTY DEFENSE.

MISSION: BLACK ATTACKS TO SEIZE CHEETAH AND TO DESTROY THREAT DEFENSES IN ZONE.

RED, ATTACK FROM CURRENT POSITIONS ALONG RICK ON ORDER.

WHITE, CONSOLIDATE ON WEST SIDE 59. ATTACK WEST BY NORTH-WEST ALONG ROAD COMPLEX NORTH SIDE OF RICK ON ORDER.

GREEN, FOLLOW AND SUPPORT WHITE.

FIST, PRIORITY OF FIRES TO WHITE. PRIORITY TARGET IS ALPHA ALPHA 40.

WHITE AND RED, MOVE INDEPENDENTLY TO AND LINK UP AT FOUR.

ACKNOWLEDGE, OVER.

[Allow all stations to respond.]

Annex 4

Target Sequence

EVENT	CUE	TARGETS EXPOSED	EXPOSURE TIME	REMARKS
1.1	Plt crosses LD/LC (273450).	6	20 Sec	Weapons Effect Simulator (WES) fired 5-8 Sec after target presented.
1.2	Plt arrives CP 1 (268452).	14 + Trps	20 Sec	" "
1.3	10 Sec after 1.2 initiated	16 + Trps	20 Sec	" "
1.4	Plt arrives CP 2 (261454).	27	20 Sec	" "
2.1	Plt crosses PL Mary (260455).	31, 33, 34, 36	40 Sec	WES fired 5-8 Sec after targets are presented.
2.2	15 - 20 Sec after 2.1 initiated	21, 22, 23	30 Sec	" "
2.3	Plt crosses lateral unimproved road (255456).	25, 26, 30	20 Sec	
2.4	Plt crosses intermittent stream bed (254457).	37, 38, 39, 40	40 Sec	WES fired 5-10 Sec after 1st tank enters hull-down vic. CP 4.
3.1	First section begins bound (withdrawal) from CP 4 to CP 2.	41, 42, 43	24 Sec	
3.2	1 minute after initiation of 3.1	37, 38, 39, 40	24 Sec	
3.3	2 minutes after initiation of 3.1	29, 33, 34, 35, 36	36 Sec	If 2nd section has not begun displacement, presentation is delayed 15-20 Sec after 2nd section begins its move.
3.4	1 min, 30 Sec after initiation of 3.3	18, 19, 20, 21 + Trps, 22 + Trps, 23 + Trps	24 Sec	

EVENT	CUE	EXPOSED	TARGETS TIME	EXPOSURE REMARKS
4.0	PLT acknowledges SPOT Report (events 44-46, MEL).	18, 19, 20, 24, 27, 28, 31, 32, 33, 34, 37, 38	40 Sec	Presentation delayed 30-60 Sec after radio conversation.
5.1	RED acknowledges SITREP from Co/Tm, and mission to continue defending vic. CP 2.	29, 33, 34, 35	24 Sec	Delay presentation 15-20 Sec after cue.
5.2	1 minute after initiation of 5.1	21, 22, 23	24 Sec	
5.3	2 minutes after initiation of 5.1	18, 19, 24, 27	24 Sec	Platoon ordered to move to supplemental position, orient east.
5.4	3 minutes after initiation of 5.1	4, 5, 11A, 12A, 13A	24 Sec	
6.0	Lead Section of RED occupies CP 1, trail section is bounding.	11B, 12B 10 9 8 50, 13 7, 14, 15, 16, 17	33 Sec 35 Sec 36 Sec 38 Sec 41 Sec 45 Sec	If lead section continues to move through CP 1, present all targets immediately. Otherwise delay presentation 30-45 Sec after lead section occupies CP 1. 25 Sec into engagement, WHITE (notional tank platoon) occupies adjacent position and engages north half of array.

Target List

Target numbers correspond to numbers assigned to target pits for PRIME.

Suffixes (A,B) on selected targets indicate additional targets required within same general location with different silhouettes and different orientations.

Orientations indicate the direction that the exercising unit (center of mass) is expected to be from the target location.

TARGET NUMBER	TYPE	ORIENTATION	USED IN TARGET SETS:
4	BMP Flank	West	5.4
5	Tank Flank	West	5.4
6	BMP Front	SE	1.1
7	BMP Front	SE	6.0
8	BMP Front	SE	6.0
9	BMP Front	SE	6.0
10	BMP Front	SE	6.0
11A	BMP Flank	SW	5.4
11B	BMP Front	SE	6.0
12A	BMP Flank	SW	5.4
12B	Tank Front	SE	6.0
13A	Tank Flank	West	5.4
13B	Tank Front	SE	6.0
14	BMP Front	ESE	1.2*, 6.0
15	BMP Front	ESE	6.0
16	BMP Front	ESE	1.3*, 6.0
17	Tank Front	East	6.0
18	Tank Front	SE	3.4, 4.0, 5.3
19	Tank Front	SE	3.4, 4.0, 5.3
20	Tank Front	SE	3.4, 4.0
21	BMP Front	ENE	2.2, 3.4*, 5.2
22	BMP Front	ENE	2.2, 3.4*, 5.2
23	BMP Front	ENE	2.2, 3.4*, 5.2
24	BMP Front	SE	4.0, 5.3
25	Tank Front	South	2.3
26	Tank Front	South	2.3
27	BMP Front	SE	1.4, 4.0, 5.3
28	BMP Front	SE	4.0
29	Tank Front	SE	3.3, 5.1
30	Tank Front	South	2.3
31	BMP Front	SE	2.1, 4.0
32	BMP Front	SE	4.0
33	BMP Front	ESE	2.1, 3.3, 4.0, 5.1
34	BMP Front	ESE	2.1, 3.3, 4.0, 5.1
35	Tank Front	East	3.3, 5.1

* Target presented with 5-10 troop silhouettes.

TARGET NUMBER	TYPE	ORIENTATION	USED IN TARGET SETS:
36	Tank Front	East	2.1, 3.3
37	BMP Front	East	2.4, 3.2, 4.0
38	BMP Front	East	2.4, 3.2, 4.0
39	Tank Front	East	2.4, 3.2
40	Tank Front	ESE	2.4, 3.2
41	Tank Front	SE	3.1
42	Tank Front	ESE	3.1
43	BMP Front	ESE	3.1
50	Tank Front	SE	6.0

Annex 5

Scoring Packet

The scoring packet for the sample scenario would typically include a complete set of scoring criteria. Two of the enclosures to this sample packet are omitted and cross-referenced to other parts of the report to eliminate unnecessary duplication. The two missing parts are summarized below.

Hit Scoring Procedure. The specific data for platoon level gunnery has not yet been developed, but the methodology was addressed in Chapter 3 of this report. A portion of the scoring packet would be array (engagement/target set) specific criteria for use by the control and evaluation team. These would be generated in the form of worksheets that are used by the evaluation team for data collection. The raw data would be entered into a computer and the final scoring be generated from a Lotus program similar to the crew level program introduced in Chapter 3.

Summative Rating Scales. The summative rating for the unit would be made on the Platoon and Platoon Leader/Platoon Sergeant Behavior Description Scales which are in Appendix B. In any particular test, the specific data required by the test may allow some selection from among the rating scales, in which case the entire packet need not be reproduced. In the example, all platoon and platoon leader/platoon sergeant scales would be incorporated.

Annex 7

Evaluation Criteria/Engagement Matrix

EVALUATION CRITERIA Facet	EVALUATE: PRIOR TO EXERCISE	DURING ENGAGEMENT # 1	2	3	4	5	6
Platoon							
ROUTE SELECTION							
Uses appropriate route.		X	X	X		X	X
Uses cover & concealment.		X	X	X		X	X
Uses reduced visibility.		X	X	X		X	X
Avoids untrafficable terrain.		X	X	X		X	X
MOVEMENT							
Uses suitable mvt tech & formation.		X	X	X		X	X
Maintains stable formation.		X	X	X		X	X
Adjusts formation to terrain.		X	X	X		X	X
Uses suitable movement rate.		X	X	X		X	X
Bounds don't out-distance overwatch.		X	X	X		X	X
Changes direction/formation quickly.		X	X	X		X	X
INTRA-POSITION MOVEMENT							
Tanks properly occupy positions. (hide, turret-, hull-down).	X	X	X	X	X	X	X
Tanks coordinate movement, fires.			X	X	X	X	X
Tanks maximize exposure in hull-down.			X	X	X	X	X
Tanks avoid AT fires.			X	X	X	X	X
Tanks use speed/covered & concealed routes between firing positions.				X	X	X	X
Rehearses movement between positions.							
Complies with movement restrictions.	X						
ORIENTATION (DEFENSE)							
Covers primary sector effectively.	X			X	X	X	
Maintains internal mutual support.	X			X	X	X	
Maintains all-round security.	X			X	X	X	
Complies with REDCON.	X			X	X	X	
Performs proper actions on contact.				X	X	X	
ORIENTATION (OFFENSE)							
Orients on primary threat.		X	X				X
Tanks orient per formation.		X	X				X
Maintains internal/external mutual support.		X	X				X
Provides continuous overwatch.							X
Shifts orientation per moving element.							X
Returns fire immediately on contact.		X	X				X
Reports contact immediately.		X	X				X
Executes appropriate drills immediately on contact.		X	X				X

EVALUATION CRITERIA Facet	EVALUATE: PRIOR TO EXERCISE	DURING ENGAGEMENT # 1	2	3	4	5	6
DIRECT FIRES							
Distributes fires effectively.		X	X	X	X	X	X
Complies with higher fire distr.		X	X			X	X
Engages per target classifications.		X	X	X	X	X	X
Engages per target range.		X	X	X	X	X	X
Uses suitable volume of fires.		X	X	X	X	X	X
Shifts/ceases fires when suitable.		X	X	X	X	X	X
COMMUNICATION							
Crews use proper RTP.	X	X	X	X	X	X	X
NCS maintains network discipline.	X	X	X	X	X	X	X
Crews transmit clear, brief msgs.	X	X	X	X	X	X	X
Uses COMSEC eqpt.	X	X	X	X	X	X	X
Uses visual communication.	X	X	X	X	X	X	X
Uses wire communication.	X						
Uses messengers.	X						
Crews transmit timely, accurate messages.	X	X	X	X	X	X	X
Platoon Leader/Platoon Sergeant							
FIRE PLANNING							
Orients platoon to terrain.	X			X	X	X	X
Designates tank positions.	X			X	X	X	X
Designates primary sectors.	X			X	X	X	X
Designates DF control measures.	X			X	X	X	
Provides for mutual support.	X			X	X	X	X
Documents fire plan (time permitting).	X						
Verifies sector coverage from firing posns (time permitting).	X						
FIRE COMMANDS							
Issues clear, brief fire commands.		X	X	X	X	X	X
Uses suitable fire pattern/ technique.		X	X	X	X	X	X
Issues effective fire commands.		X	X	X	X	X	X

EVALUATION CRITERIA Facet	EVALUATE: PRIOR TO EXERCISE	DURING ENGAGEMENT # 1	 2	 3	 4	 5	 6
REQUEST INDIRECT FIRES							
Designates indirect fire control measures.	X						
Makes clear, brief, accurate Calls for fire.		X	X	X	X	X	X
Uses FA/Mort to suppress or to reinforce direct fires.		X	X	X	X	X	X
Uses indirect smoke effectively.		X	X	X	X	X	X
Coordinates FA/Mort with plt movement and fires.		X	X	X	X	X	X
OPERATIONS ORDERS							
Issues clear, brief orders.	X						
Uses standard format, includes all essential information.	X						
Complies with commander's intent.	X						
Provides for mutual support.	X						
Plans effective use of cover & concealment.	X						
Plans for known/likely enemy action.	X						
Plans for likely contingencies.	X						
FRAGMENTARY ORDERS							
Uses only when req'd to refine/ modify plan.	X	X	X	X	X	X	X
Conforms with commander's intent.	X	X	X	X	X	X	X
Issues clear, brief, timely FRAGOs.	X	X	X	X	X	X	X
SUPERVISION							
Insures subordinate's understanding.	X			X	X	X	X
Resolves problems in OPORD, rehearsal, inspection, back-brief.	X						
Monitors/corrects subordinates during execution.	X	X	X	X	X	X	X
Issues clear, brief, specific correctives.	X	X	X	X	X	X	X
Uses situational leadership.	X	X	X	X	X	X	X

Annex 7

Engagement Worksheets

PRE-EXERCISE EVENTS

CONDITIONS. The platoon is in a tactical assembly area. The company team commander directs the platoon to perform sustainment operations pending receipt of the new mission. As the platoon performs sustainment, the company team commander receives the battalion task force operation order. The company commander issues a Warning Order over the radio about three and one-half hours before the exercise start-time. The company team commander issues his operations order about three hours before the exercise start-time. As the platoon continues preparations, the company team commander receives the platoon leader's back-brief and observes the platoon leader's OPORD and rehearsal.

Evaluation Criteria: Pldr/PSG
Observation codes: + = good; o = o.k.; - = bad (leave blank if not observed).

FIRE PLANNING
___Orients plt to terrain.
___Designates tank positions.
___Designates primary sectors.
___Designates DF control measures.
___Provides for mutual support.
___Documents fire plan (time permitting).
___Verifies sector coverage from firing posns (time permitting).

SUPERVISION
___Insures subordinates understand.
___Resolves problems in OPORD, rehearsal, inspection, back-brief.
___Monitors/corrects subordinates during execution.
___Issues clear, brief, specific correctives.
___Uses situational leadership.

OPERATIONS ORDERS
___Issues clear, brief orders.
___Uses standard format, includes all essential information.
___Complies with commander's intent.
___Provides for mutual support.
___Plans effective use of cover & concealment.
___Plans for known/likely enemy action.
___Plans for likely contingencies.

REQUEST INDIRECT FIRES
___Designates indirect fire control measures.

FRAGMENTARY ORDERS
___Uses only when req'd to refine/modify plan.
___Conforms with commander's intent.
___Uses clear, brief, timely FRAGOs.

NOTES.

PRE-EXERCISE EVENTS

Evaluation Criteria: Platoon
Observation codes: + = good; o = o.k.; - = bad (leave blank if not observed).

INTRA-POSITION MOVEMENT
___Tanks properly occupy positions (hide, turret-down, hull-down).
___Complies with mvt restrictions.

ORIENTATION (DEFENSE)
___Covers primary sector effectively.
___Maintains internal mutual support.
___Maintains all-round security.
___Complies with REDCON.

COMMUNICATION
___Crews use proper RTP.
___NCS maintains network discipline.
___Crews transmit clear, brief msgs.
___Uses COMSEC equiptment.
___Uses visual communication.
___Uses wire communication.
___Uses messengers.
___Crews transmit timely, accurate messages.

NOTES.

ENGAGEMENT 1. TANK PLATOON ATTACK AGAINST THREAT WITHDRAWAL

CONDITIONS. The platoon is moving as the lead element of the company team. The platoon moves in column along the designated route to PP 3, through passage lane XEROX, and across the LD/LC. The company team (notional) deploys into a wedge with the exercised platoon on point. The platoon encounters a series of 4 BMPs simulating elements in the threat security zone. Targets are presented singly, and each remains up for 20 seconds. Targets 2 and 3 include troops, and presentations of 2 and 3 overlap.

Evaluation Criteria: Pldr/PSG
Observation codes: + = good; o = o.k.; - = bad (leave blank if not observed).

FIRE COMMANDS
___Uses clear, brief fire commands.
___Uses suitable fire pattern/technique.
___Issues effective fire commands.

REQUEST INDIRECT FIRES
___Makes clear, brief, accurate calls for fire.
___Uses FA/Mort to suppress or to reinforce direct fires.
___Uses indirect smoke effectively.
___Coordinates FA/Mort with plt movement and fires.

FRAGMENTARY ORDERS
___Uses only when req'd to refine/modify plan.
___Conforms with commander's intent.
___Uses clear, brief, timely FRAGOs.

SUPERVISION
___Monitors/corrects subordinates during execution.
___Issues clear, brief, specific correctives.
___Uses situational leadership.

NOTES.

ENGAGEMENT 1. TANK PLATOON ATTACK AGAINST THREAT WITHDRAWAL

Evaluation Criteria: Platoon
Observation codes: + = good; o = o.k.; - = bad (leave blank if not observed).

ROUTE SELECTION
___Uses appropriate route.
___Uses cover & concealment.
___Uses reduced visibility.
___Avoids untrafficable terrain.

MOVEMENT
___Uses suitable mvt tech/formation.
___Maintains stable formation.
___Adjusts formation to terrain.
___Uses suitable movement rate.
___Bounds don't out-run overwatch.
___Changes direction/formation quickly.

ORIENTATION (OFFENSE)
___Orients on primary threat.
___Tanks orient per formation.
___Maintains internal/external mutual support.
___Returns fire immediately on contact.
___Reports contact immediately.
___Executes appropriate drills immediately on contact.

INTRA-POSITION MOVEMENT
___Tanks properly occupy positions (hide, turret-down, hull-down).

DIRECT FIRES
___Distributes fires effectively.
___Complies w/higher fire distr.
___Engages per target classification.
___Engages per target range.
___Uses suitable volume of fires.
___Shifts/ceases fires when suitable.

COMMUNICATION
___Crews use proper RTP.
___NCS maintains network discipline.
___Crews transmit clear, brief msgs.
___Uses COMSEC equiptment.
___Uses visual communication.
___Crews transmit timely, accurate messages.

NOTES.

ENGAGEMENT 2. TANK PLATOON ATTACK AGAINST THREAT DEFENSE.

CONDITIONS. The company team has reached CP 2. The exercised platoon is continuing the attack as the lead element of the company team with overwatch provided by a tank platoon and a mech (Bradley) platoon. As the platoon moves, it is engaged by three sets of targets representing a motorized rifle company defensive strong-point and one set of targets representing a tank platoon (counterattack force).

Evaluation Criteria: Pldr/PSG
Observation codes: + = good; o = o.k.; - = bad (leave blank if not observed).

FIRE COMMANDS
___Uses clear, brief fire commands.
___Uses suitable fire pattern/ technique.
___Issues effective fire commands.

REQUEST INDIRECT FIRES
___Makes clear, brief, accurate calls for fire.
___Uses FA/Mort to suppress or to reinforce direct fires.
___Uses indirect smoke effectively.
___Coordinates FA/Mort with platoon movement and fires.

FRAGMENTARY ORDERS
___Uses only when req'd to refine/ modify plan.
___Conforms with commander's intent.
___Uses clear, brief, timely FRAGOs.

SUPERVISION
___Monitors/corrects subordinates during execution.
___Issues clear, brief, specific correctives.
___Uses situational leadership.

NOTES.

ENGAGEMENT 2. TANK PLATOON ATTACK AGAINST THREAT DEFENSE.

Evaluation Criteria: Platoon
Observation codes: + = good; o = o.k.; - = bad (leave blank if not observed).

ROUTE SELECTION
___Uses appropriate route.
___Uses cover & concealment.
___Uses reduced visibility.
___Avoids untrafficable terrain.

MOVEMENT
___Uses suitable mvt tech/formation.
___Maintains stable formation.
___Adjusts formation to terrain.
___Uses suitable movement rate.
___Bounds don't out-run overwatch.
___Chgs direction/formation quickly.

ORIENTATION (OFFENSE)
___Orients on primary threat.
___Tanks orient per formation.
___Maintains internal/external mutual support.
___Returns fire immediately on contact.
___Reports contact immediately.
___Executes appropriate drills immediately on contact.

INTRA-POSITION MOVEMENT
___Tanks properly occupy positions (hide, turret-down, hull-down).
___Tanks coord. movement, fires.
___Tanks maximize exposure:hull-down.
___Tanks avoid AT fires.

DIRECT FIRES
___Distributes fires effectively.
___Complies w/higher fire distr.
___Engages per target classification.
___Engages per target range.
___Uses suitable volume of fires.
___Shifts/ceases fires when suitable.

COMMUNICATION
___Crews use proper RTP.
___NCS maintains network discipline.
___Crews transmit clear, brief msgs.
___Uses COMSEC equiptment.
___Uses visual communication.
___Crews transmit timely, accurate messages.

NOTES.

ENGAGEMENT 3. TANK PLATOON DEFEND AGAINST THREAT MEETING ENGAGEMENT

CONDITIONS. The platoon is covering the movement of the company team to a blocking position north of their current position. As the company team moves, the platoon is to withdraw and defend the team's left flank from vicinity CP 2. The remainder of the company team cannot cover the platoon's movement. As the platoon begins its movement, the platoon observes the first of four sets of targets representing elements of a MRC advancing through CP 4 toward CP 2. The targets simulate the forward security element of the regimental advance guard battalion.

Evaluation Criteria: Pldr/PSG
Observation codes: + = good; o = o.k.; - = bad (leave blank if not observed).

FIRE PLANNING
___Orients platoon to terrain.
___Designates tank positions.
___Designates primary sectors.
___Designates DF control measures.
___Provides for mutual support.

FIRE COMMANDS
___Uses clear, brief fire commands.
___Uses suitable fire pattern/technique.
___Issues effective fire commands.

FRAGMENTARY ORDERS
___Uses only when req'd to refine/modify plan.
___Conforms with commander's intent.
___Uses clear, brief, timely FRAGOs.

REQUEST INDIRECT FIRES
___Makes clear, brief, accurate calls for fire.
___Uses FA/Mort to suppress or to reinforce direct fires.
___Uses indirect smoke effectively.
___Coordinates FA/Mort with platoon movement and fires.

SUPERVISION
___Monitors/corrects subordinates during execution.
___Issues clear, brief, specific correctives.
___Uses situational leadership.

NOTES.

ENGAGEMENT 3. TANK PLATOON DEFEND AGAINST THREAT MEETING ENGAGEMENT

Evaluation Criteria: Platoon
Observation codes: + = good; o = o.k.; - = bad (leave blank if not observed).

ROUTE SELECTION
___Uses appropriate route.
___Uses cover & concealment.
___Uses reduced visibility.
___Avoids untrafficable terrain.

MOVEMENT
___Uses suitable mvt tech/formation.
___Maintains stable formation.
___Adjusts formation to terrain.
___Uses suitable movement rate.
___Bounds don't out-run overwatch.
___Chgs direction/formation quickly.

INTRA-POSITION MOVEMENT
___Tanks properly occupy positions (hide, turret-down, hull-down).
___Tanks coord. movement, fires.
___Tanks maximize exposure:hull-down.
___Tanks avoid AT fires.
___Tanks use speed/covered&concealed routes between firing positions.

ORIENTATION (DEFENSE)
___Covers primary sector effectively.
___Maintains internal mutual support.
___Maintains all-round security.
___Complies with REDCON.
___Performs actions on contact.

DIRECT FIRES
___Distributes fires effectively.
___Engages per target classification.
___Engages per target range.
___Uses suitable volume of fires.
___Shifts/ceases fires when suitable.

COMMUNICATION
___Crews use proper RTP.
___NCS maintains network discipline.
___Crews transmit clear, brief msgs.
___Uses COMSEC equiptment.
___Uses visual communication.
___Crews transmit timely, accurate messages.

NOTES.

ENGAGEMENT 4. TANK PLATOON DEFEND AGAINST THREAT DELIBERATE ATTACK

CONDITIONS. The platoon is defending from CP 2. The company team is engaged to the north and cannot support the platoon. A motorized rifle company with tanks attacks the platoon position. The array simulates a motorized rifle company in the regimental advance guard battalion seeking a bypass around the defenses to the north.

Evaluation Criteria: Pldr/PSG
Observation codes: + = good; o = o.k.; - = bad (leave blank if not observed).

FIRE PLANNING
___Orients platoon to terrain.
___Designates tank positions.
___Designates primary sectors.
___Designates DF control measures.
___Provides for mutual support.

FIRE COMMANDS
___Uses clear, brief fire commands.
___Uses suitable fire pattern/ technique.
___Issues effective fire commands.

FRAGMENTARY ORDERS
___Uses only when req'd to refine/ modify plan.
___Conforms with commander's intent.
___Uses clear, brief, timely FRAGOs.

REQUEST INDIRECT FIRES
___Makes clear, brief, accurate calls for fire.
___Uses FA/Mort to suppress or to reinforce direct fires.
___Uses indirect smoke effectively.
___Coordinates FA/Mort with platoon movement and fires.

SUPERVISION
___Monitors/corrects subordinates during execution.
___Issues clear, brief, specific correctives.
___Uses situational leadership.

NOTES.

ENGAGEMENT 4. TANK PLATOON DEFEND AGAINST THREAT DELIBERATE ATTACK

Evaluation Criteria: Platoon
Observation codes: + = good; o = o.k.; - = bad (leave blank if not observed).

ORIENTATION (DEFENSE)
___Covers primary sector effectively.
___Maintains internal mutual support.
___Maintains all-round security.
___Complies with REDCON.
___Performs actions on contact.

INTRA-POSITION MOVEMENT
___Tanks properly occupy positions (hide, turret down, hull down).
___Tanks coordinate movement, fires.
___Tanks maximize exposure:hull-down.
___Tanks avoid AT fires.
___Tanks use speed/covered&concealed routes between firing positions.

DIRECT FIRES
___Distributes fires effectively.
___Engages per target classification.
___Engages per target range.
___Uses suitable volume of fires.
___Shifts/ceases fires when suitable.

COMMUNICATION
___Crews use proper RTP.
___NCS maintains network discipline.
___Crews transmit clear, brief msgs.
___Uses COMSEC equiptment.
___Uses visual communication.
___Crews transmit timely, accurate messages.

NOTES.

ENGAGEMENT 5. TANK PLATOON DEFEND AGAINST THREAT BREAKTHROUGH

CONDITIONS. The platoon continues to defend from vicinity CP 2. The company continues to defend to the north and cannot support the exercised platoon. The platoon defends against a series of platoon-sized target arrays representing continued pressure from the west. The company team reports six threat vehicles (tanks and BMPs) breaking through their position and moving south behind the exercised platoon and orders the platoon to reorient to its rear and engage. Targets represent elements (motorized rifle company (-)) of the threat regiment in a deliberate attack against a defending enemy.

<u>Evaluation Criteria</u>: Pldr/PSG
Observation codes: + = good; o = o.k.; - = bad (leave blank if not observed).

FIRE PLANNING
___Orients platoon to terrain.
___Designates tank positions.
___Designates primary sectors.
___Designates DF control measures.
___Provides for mutual support.

FIRE COMMANDS
___Uses clear, brief fire commands.
___Uses suitable fire pattern/ technique.
___Issues effective fire commands.

FRAGMENTARY ORDERS
___Uses only when req'd to refine/ modify plan.
___Conforms with commander's intent.
___Uses clear, brief, timely FRAGOs.

REQUEST INDIRECT FIRES
___Makes clear, brief, accurate calls for fire.
___Uses FA/Mort to suppress or to reinforce direct fires.
___Uses indirect smoke effectively.
___Coordinates FA/Mort with platoon movement and fires.

SUPERVISION
___Monitors/corrects subordinates during execution.
___Issues clear, brief, specific correctives.
___Uses situational leadership.

NOTES.

ENGAGEMENT 5. TANK PLATOON DEFEND AGAINST THREAT BREAKTHROUGH

Evaluation Criteria: Platoon
Observation codes: + = good; o = o.k.; - = bad (leave blank if not observed).

ORIENTATION (DEFENSE)
___Covers primary sector effectively.
___Maintains internal mutual support.
___Maintains all-round security.
___Complies with REDCON.
___Performs actions on contact.

INTRA-POSITION MOVEMENT
___Tanks properly occupy positions (hide, turret down, hull down).
___Tanks coordinate movement, fires.
___Tanks maximize exposure:hull-down.
___Tanks avoid AT fires.
___Tanks use speed/covered&concealed routes between firing positions.

MOVEMENT
___Uses suitable mvt tech & formation.
___Maintains stable formation.
___Adjusts formation to terrain.
___Uses suitable movement rate.
___Bounds don't out-run overwatch.
___Changes direction/formation quickly.

DIRECT FIRES
___Distributes fires effectively.
___Complies with higher fire distr.
___Engages per target classification.
___Engages per target range.
___Uses suitable volume of fires.
___Shifts/ceases fires when suitable.

COMMUNICATION
___Crews use proper RTP.
___NCS maintains network discipline.
___Crews transmit clear, brief msgs.
___Uses COMSEC equiptment.
___Uses visual communication.
___Crews transmit timely, accurate messages.

ROUTE SELECTION
___Uses appropriate route.
___Uses cover and concealment.
___Uses reduced visibility.
___Avoids untrafficable terrain.

NOTES.

ENGAGEMENT 6. TANK PLATOON ATTACK AGAINST THREAT MEETING ENGAGEMENT

CONDITIONS. The threat second echelon regiment attack has been defeated. The battalion task force and company team are resuming their attack to the west. The exercised platoon has consolidated behind the original LD/LC and is now attacking along AXIS RICK through CP 1 and CP 2. The remainder of the company team cannot cover their move. The platoon encounters a MRC (-) (advance guard) between CPs 1 and 2. As the engagement proceeds, an adjacent platoon moves into position and engages the northern half of the array.

Evaluation Criteria: Pldr/PSG
Observation codes: + = good; o = o.k.; - = bad (leave blank if not observed).

FIRE PLANNING
___Orients platoon to terrain.
___Designates tank positions.
___Designates primary sectors.
___Provides for mutual support.

FIRE COMMANDS
___Uses clear, brief fire commands.
___Uses suitable fire pattern/ technique.
___Issues effective fire commands.

FRAGMENTARY ORDERS
___Uses only when req'd to refine/ modify plan.
___Conforms with commander's intent.
___Uses clear, brief, timely FRAGOs.

REQUEST INDIRECT FIRES
___Makes clear, brief, accurate calls for fire.
___Uses FA/Mort to suppress or to reinforce direct fires.
___Uses indirect smoke effectively.
___Coordinates FA/Mort with platoon movement and fires.

SUPERVISION
___Monitors/corrects subordinates during execution.
___Issues clear, brief, specific correctives.
___Uses situational leadership.

NOTES.

ENGAGEMENT 6. TANK PLATOON ATTACK AGAINST THREAT MEETING ENGAGEMENT

Evaluation Criteria: Platoon
Observation codes: + = good; o = o.k.; - = bad (leave blank if not observed).

ORIENTATION (OFFENSE)
___Orients on primary threat.
___Tanks orient per formation.
___Maintains internal/external mutual support.
___Provides continuous overwatch.
___Shifts orientation per moving element.
___Returns fire on contact.
___Reports contact immediately.
___Executes appropriate drills immediately on contact.

ROUTE SELECTION
___Uses appropriate route.
___Uses cover & concealment.
___Uses reduced visibility.
___Avoids untrafficable terrain.

MOVEMENT
___Uses suitable mvt tech/formation.
___Maintains stable formation.
___Adjusts formation to terrain.
___Uses suitable movement rate.
___Bounds don't outrun overwatch.
___Changes direction/formation quickly.

INTRA-POSITION MOVEMENT
___Tanks properly occupy positions (hide, turret-down, hull-down).
___Tanks coordinate movement, fires.
___Tanks maximize exposure:hull-down.
___Tanks avoid AT fires.
___Tanks use speed/covered & concealed routes between positions.

DIRECT FIRES
___Distributes fires effectively.
___Complies with higher fire distr.
___Engages per target classification.
___Engages per target range.
___Uses suitable volume of fires.
___Shifts/ceases fires when suitable.

COMMUNICATIONS
___Crews use proper RTP.
___NCS maintains network discipline.
___Crews transmit clear, brief msgs.
___Uses COMSEC equiptment.
___Uses visual communition.
___Crews transmit timely, accurate messages.

NOTES.

Appendix G

Tank Table Gunnery Replications for Phantom Run

CONTENTS

List of Figures

Annex 1

Tank Table VIII Replication for Phantom Run

DAY

ENGAGEMENT 1: ENGAGE SIMULTANEOUS TARGETS (DEFENSE)

1. Move from turret down to hull down position.

2. Use GAS.

3. Target Presentation and Array:

TGT 4	BMP	Range	1200-1400 m
TGT 5	RPG Team	Range	200-400 m

4. Use main gun (phantom range).

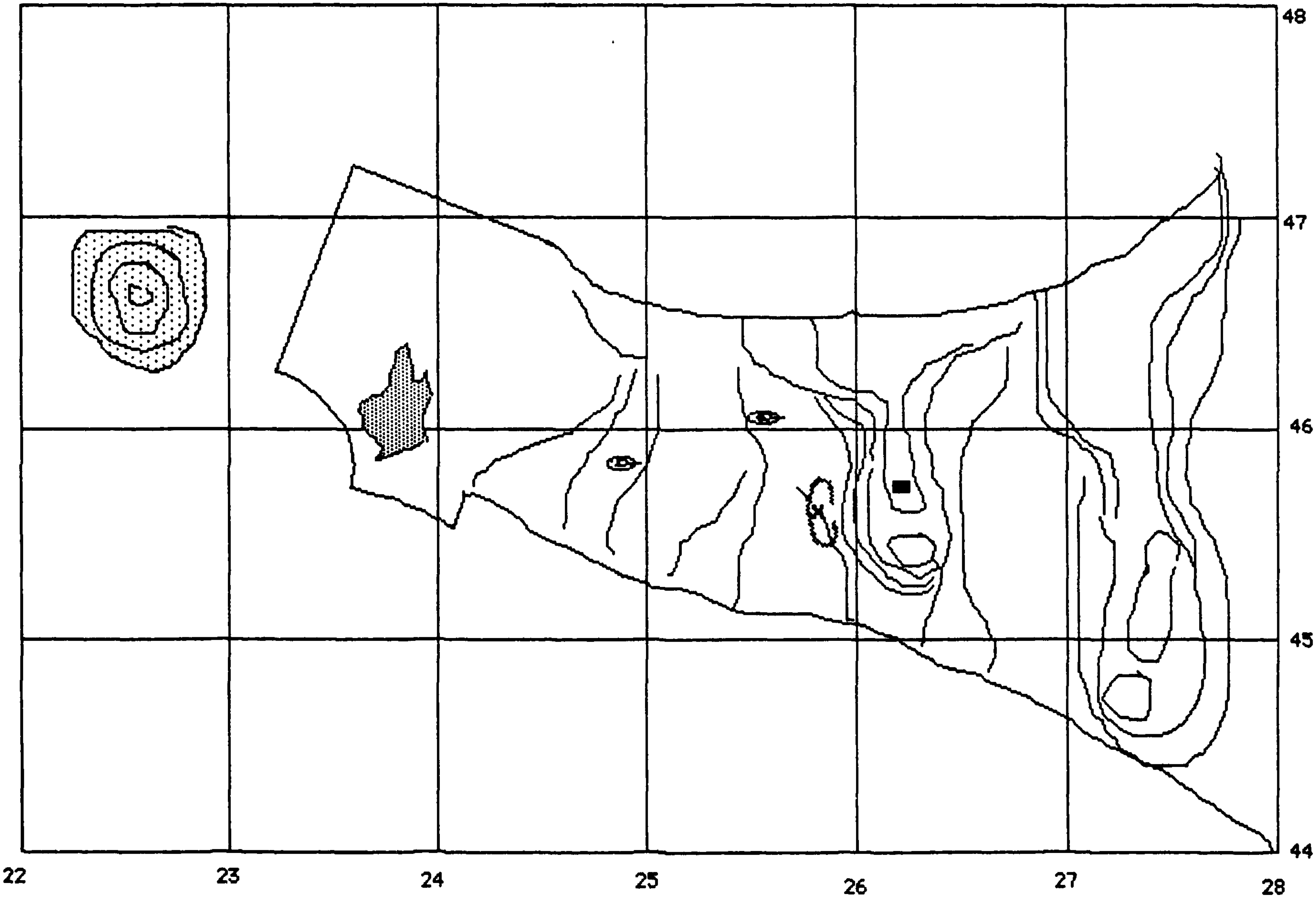


Figure G-1. Tank Table VIII engagement one.

DAY

ENGAGEMENT 2: ENGAGE MULTIPLE TARGETS (OFFENSE)

1. Use GPS, PRECISION from moving tank.

2. Target Presentation and Array:

TGT 13	Tank	Range	900-1100 m
TGT 14	Tank	Range	1400-1600 m

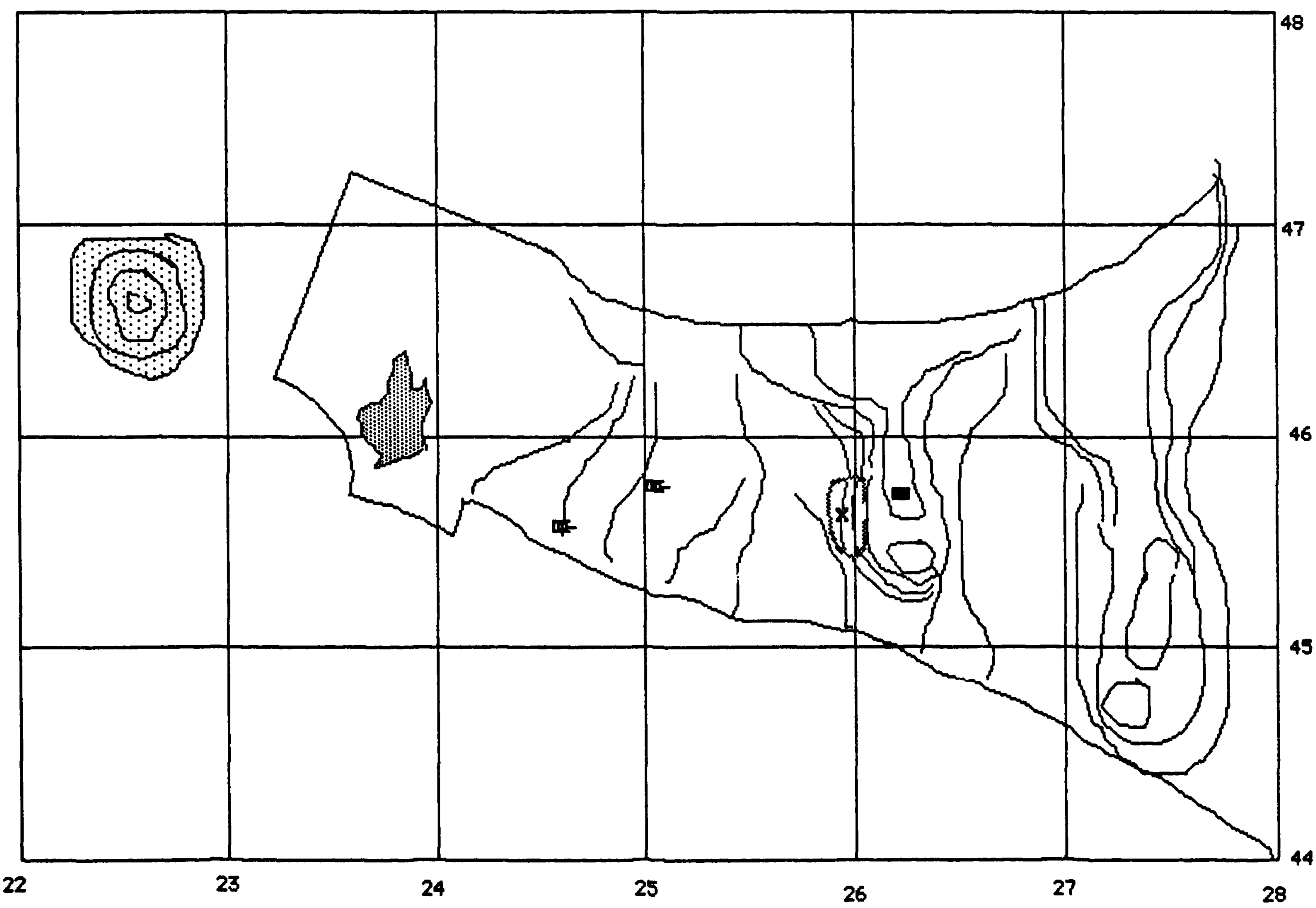


Figure G-2. Tank Table VIII engagement two.

DAY

ENGAGEMENT 3: ENGAGE MULTIPLE TARGETS (OFFENSE)

1. Use GPS from moving tank-reverse.

2. TGTS obscured by smoke.

3. Target Presentation and Array:

TGT	22	Tank	Range 1400-1600 m	stationary
TGT	33	Tank	Range 1400-1600 m	moving

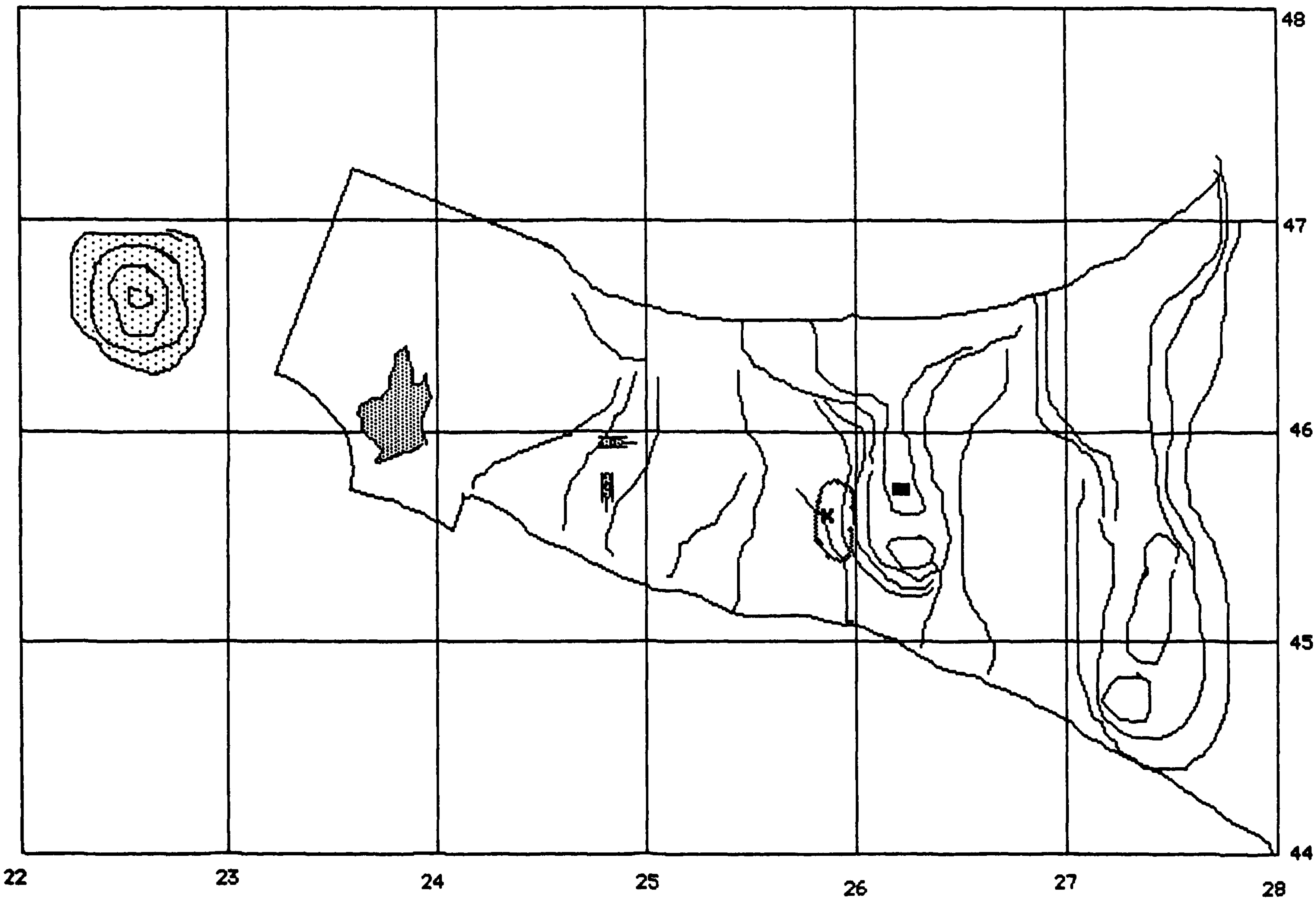


Figure G-3. Tank Table VIII engagement three.

DAY

ENGAGEMENT 4: ENGAGE MULTIPLE TARGETS (OFFENSE)

1. Use GPS from a moving tank in NBC environment.

2. Use GPS from stationary tank.

3. Target Presentation and Array:

TGT	29	BMP	Range 400-600 m	stationary
TGT	27	RPG team	Range 400-600 m	

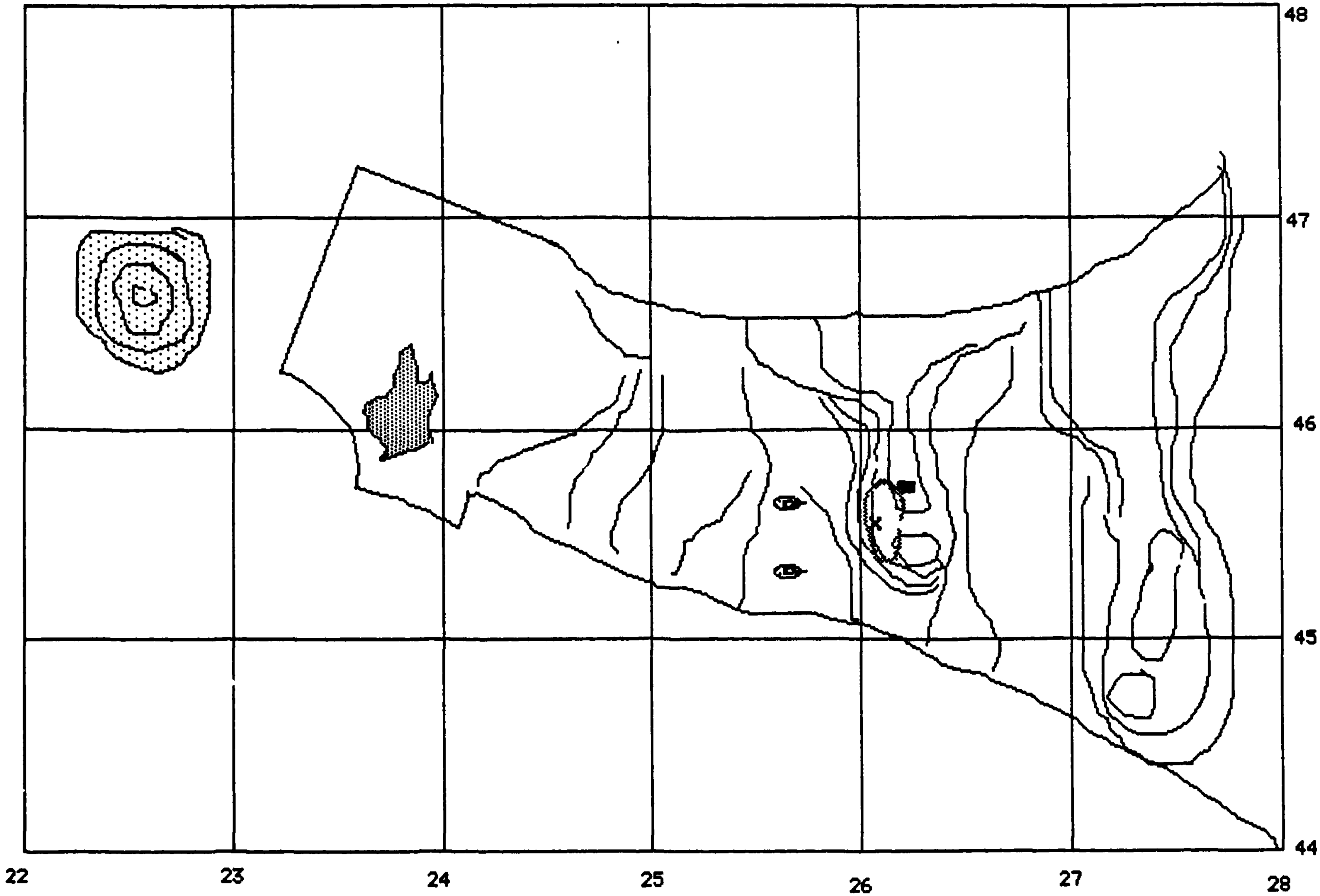


Figure G-4. Tank Table VIII engagement four.

DAY

ENGAGEMENT 5: ENGAGE A MOVING TARGET (DEFENSE)

1. Use GPS from a stationary tank.

2. Target Presentation and Array:

   TGT VISMOD Tank (moving) Range 1700-1900 m

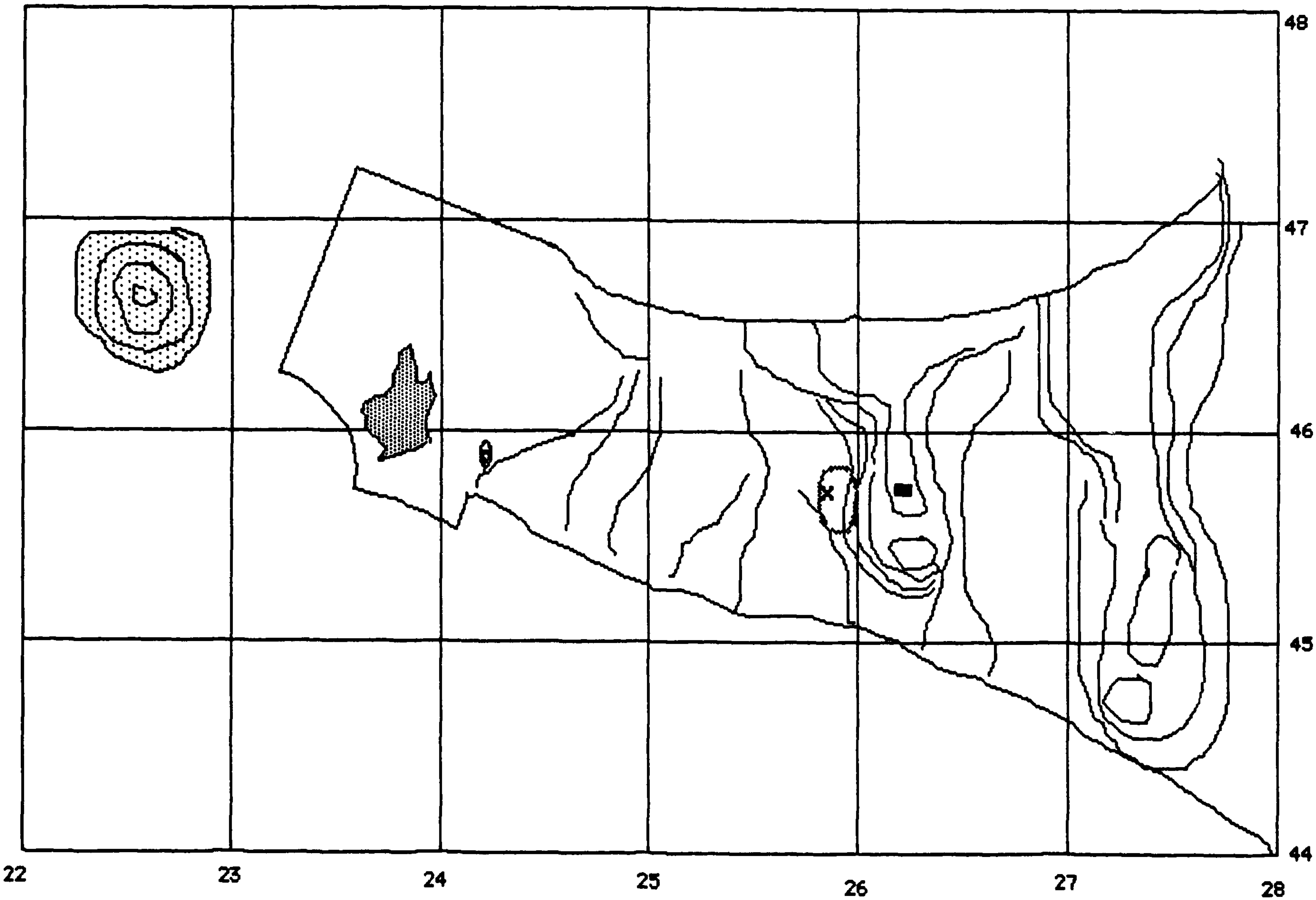


Figure G-5. Tank Table VIII engagement five.

DAY

ENGAGEMENT 6: ENGAGE MULTIPLE TARGETS (OFFENSE)

1. Use GPS, PRECISION from a moving tank in an NBC environment.

2. Target Presentation and Array:

TGT	44	Tank	Range 1400-1600 m	stationary
TGT	45	Tank	Range 1400-1600 m	stationary

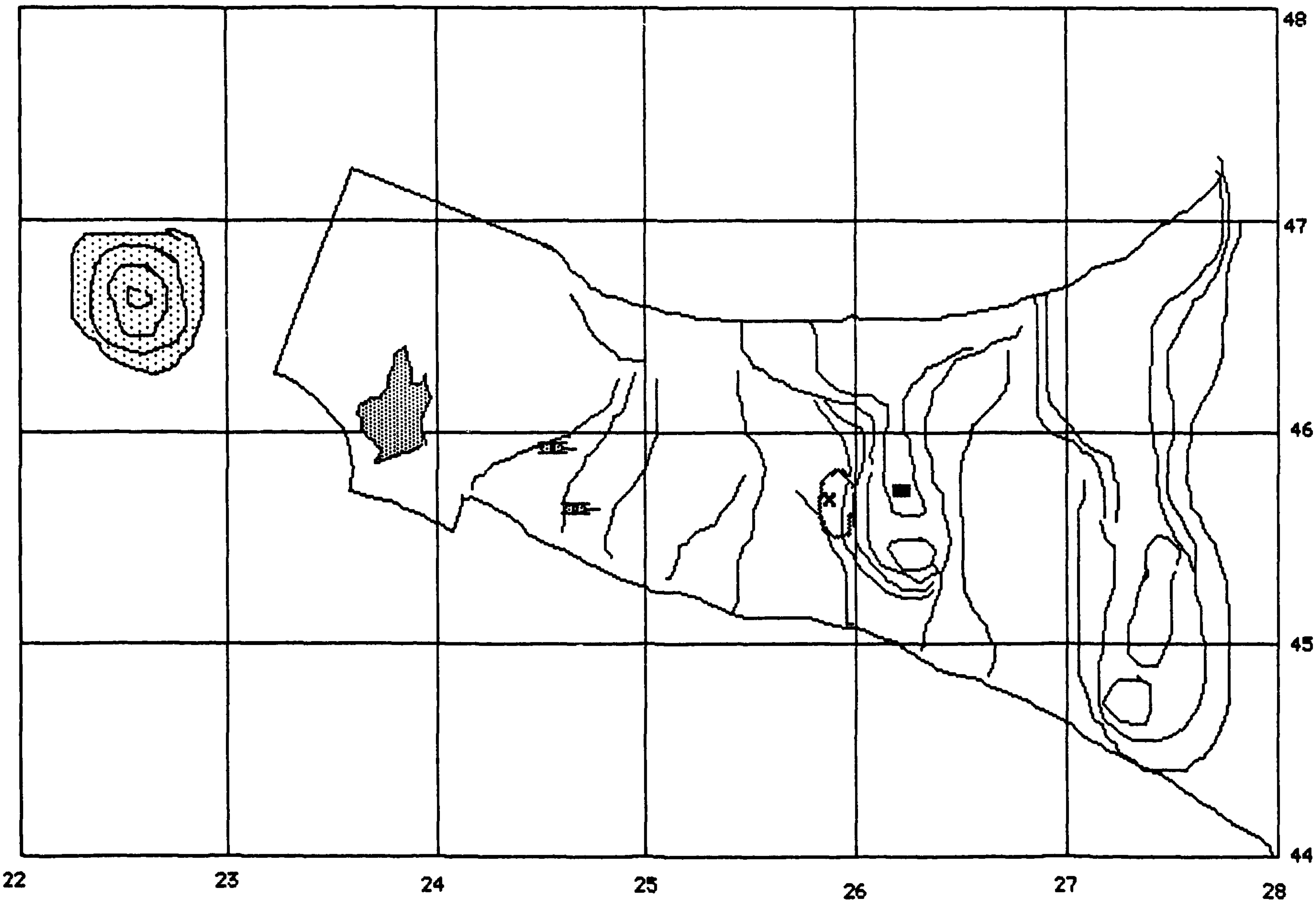


Figure G-6. Tank Table VIII engagement six.

Annex 2

Tank Table XII Replication for Phantom Run

DAY

ENGAGEMENT 1: DEFEND A PREPARED BATTLE POSITION

1. The platoon BP is a prepared position to include OPs.

2. An engagement area is identified.

3. Target Presentation and Array:

TGT	50	Tank	Range 1800-2000 m
TGT	14	Tank	
TGT	7	Tank	(may substitute all BMP @ different
TGT	8	Tank	ranges) 1400-1600 m
TGT	15	Tank	
TGT	50	BMP	Range 1400-1600 m
TGT	14	BMP	
TGT	7	BMP	(may substitute all Tank @ different
TGT	8	BMP	ranges) 1200-1400 m
TGT	15	BMP	

Figure G-7. Tank Table XII engagement one.

DAY

ENGAGEMENT 2: PROVIDE OVERWATCH THROUGH SMOKE

1. Platoon overwatches a 2nd platoon.

2. Overwatching platoon's movement is masked by smoke.

3. Target Presentation and Array:

TGT	VISMOD	Tank (moving)	Range 1200-1600 m
TGT	VISMOD	Tank (moving)	
TGT	11	Tank (stationary)	
TGT	12	Tank (stationary)	
TGT	17	Tank (stationary)	

*Note - Tanks may be substituted with BMP @ range 1000-1400 m.

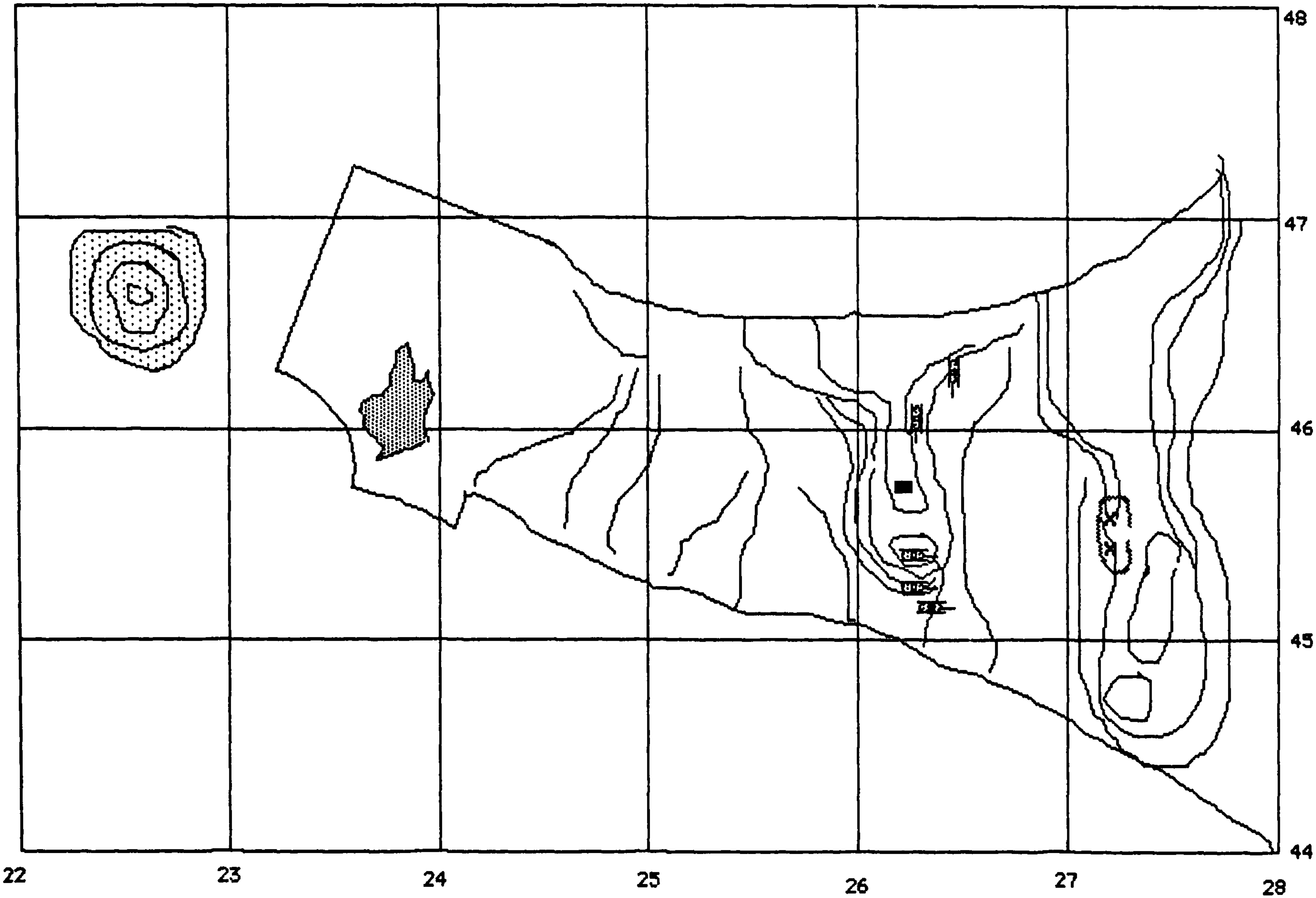


Figure G-8. Tank Table XII engagement two.

DAY

ENGAGEMENT 3: BOUND TO SUBSEQUENT BATTLE POSITION

1. Platoon must bound to another battle position.

2. No overwatch is available from another platoon.

3. Platoon must bound by section.

4. Target Presentation and Array:

TGT	19	Tank	Range 800-1000 m
TGT	20	Tank	
TGT	21	Tank	
TGT	22	ATGM	Range 600-900 m
TGT	23	ATGM	

*Note - Tank may be substituted with BMP @ range 600-900 m.

Figure G-9. Tank Table XII engagement three.

DAY

ENGAGEMENT 4: CONDUCT MOVEMENT TO CONTACT

1. Platoon is moving and overwatched by another platoon.

2. Target Presentation and Array:

TGT	36	Tank	Range 1500-1800 m
TGT	35	Tank	
TGT	34	Tank	
TGT	33	Tank	
TGT	32	ATGM	Range 600-800 m

*Note - BMP may be substituted @ range 1300-1600 m.

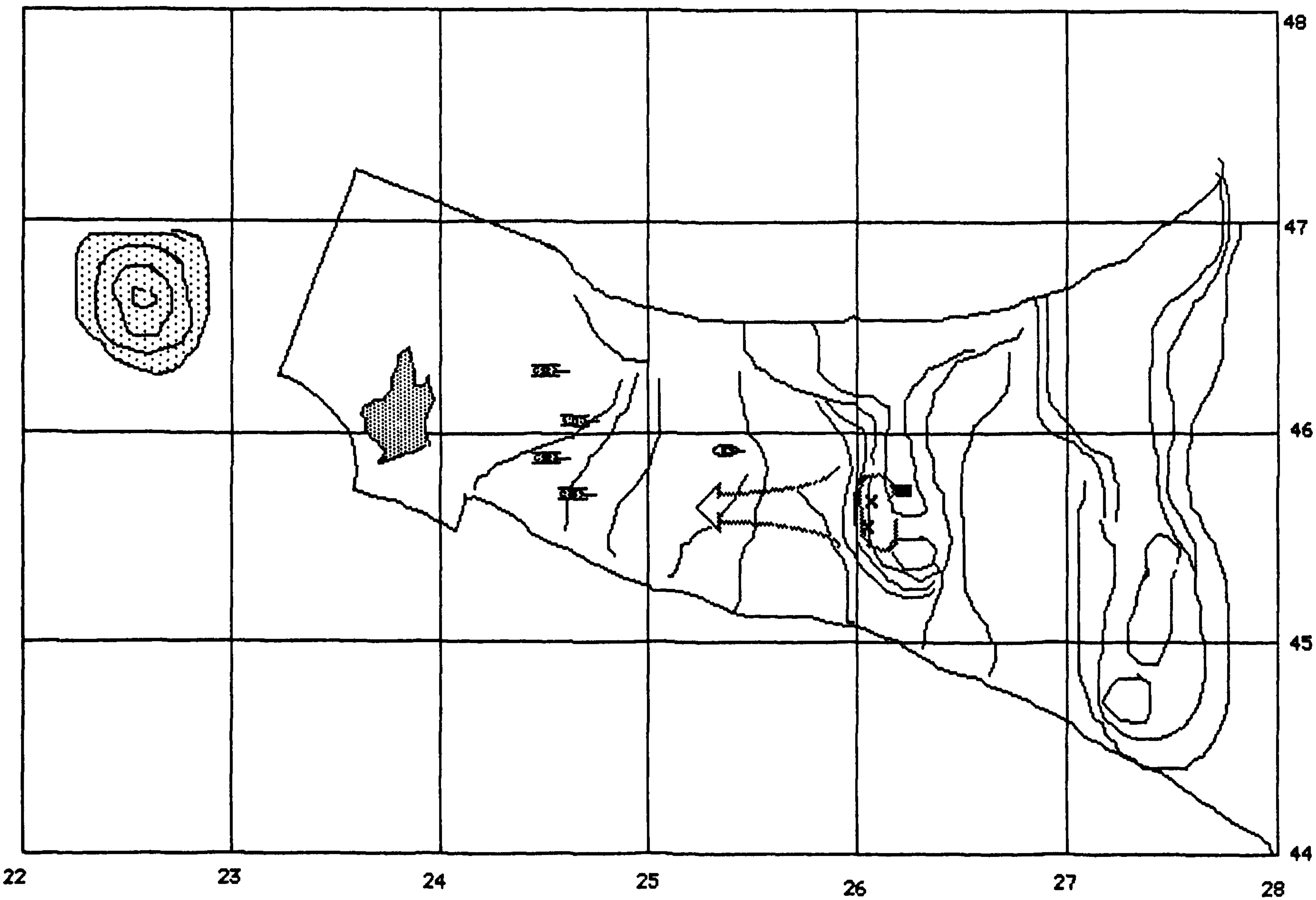


Figure G-10. Tank Table XII engagement four.

DAY

ENGAGEMENT 5: CONDUCT MOVEMENT TO CONTACT (MOPP)

1. Platoon is moving and being overwatched by adjacent platoon.

2. Platoon is in MOPP 3 and in a chemically contaminated area.

3. Target Presentation and Array:

TGT	24	Tank	Range 1200-1400 m
TGT	25	Tank	
TGT	29	Tank	
TGT	31	Tank	
TGT	28	ATGM	Range 800-900 m
TGT	26	ATGM	
TGT	27	ATGM	

*Note BMP may be substituted @ range 1000-1200 m.

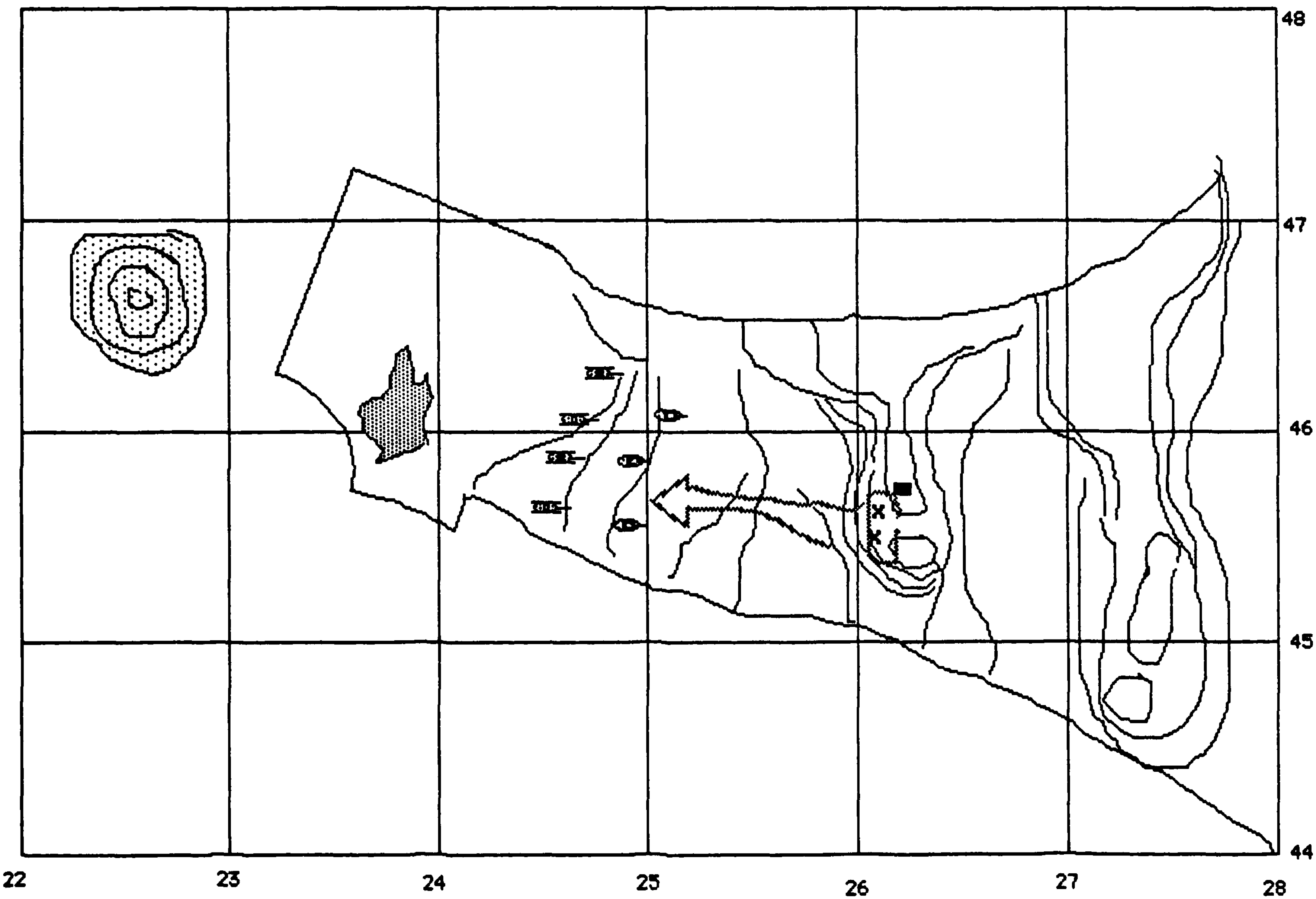


Figure G-11. Tank Table XII engagement five.

DAY

ENGAGEMENT 6: CONDUCT MOVEMENT TO CONTACT-BOUNDING OVERWATCH

1. Platoon is bounding by section.

2. Forward section is overwatch section.

3. Rear section is bounding and is engaged by enemy.

4. Target Presentation and Array:

TGT	18	Tank	Range 1000-1400 m
TGT	25	Tank	
TGT	26	Tank	

*Note BMP may be substituted @ range 1000-1200 m.

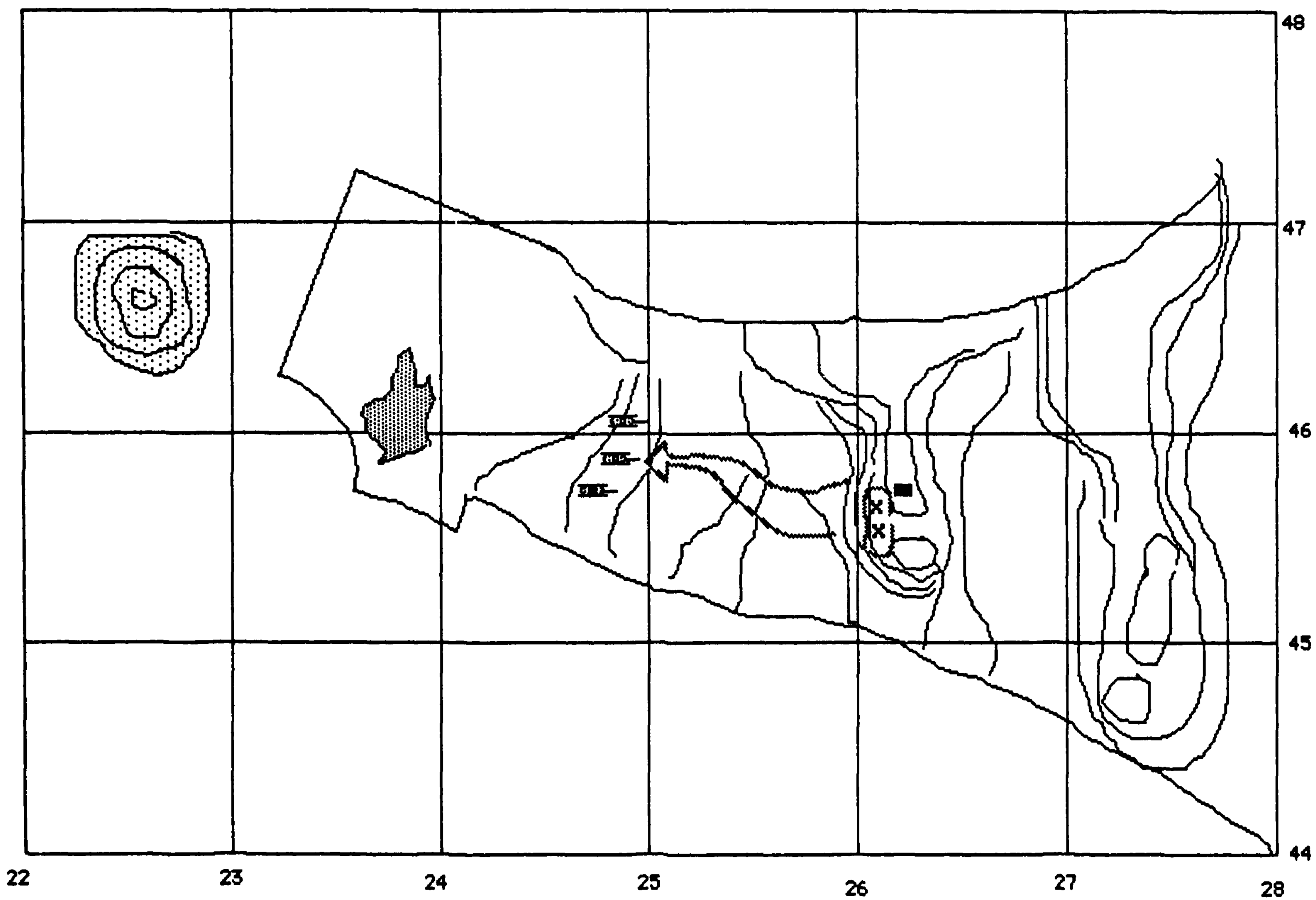


Figure G-12. Tank Table XII engagement six.

NIGHT

ENGAGEMENT 7: BOUND TO SUBSEQUENT BATTLE POSITION

1. Platoon moves to a subsequent battle position. No overwatch is provided by adjacent platoon.

2. Platoon bounds by section.

3. Bounding section is engaged by enemy.

4. Target Presentation and Array:

TGT	37	Tank	Range 800-1000 m
TGT	38	Tank	
TGT	39	Tank	
TGT	40	ATGM	Range 1300-1500 m

*Note BMPs may be substituted @ range 600-900 m.

5. Engagement is performed with illumination.

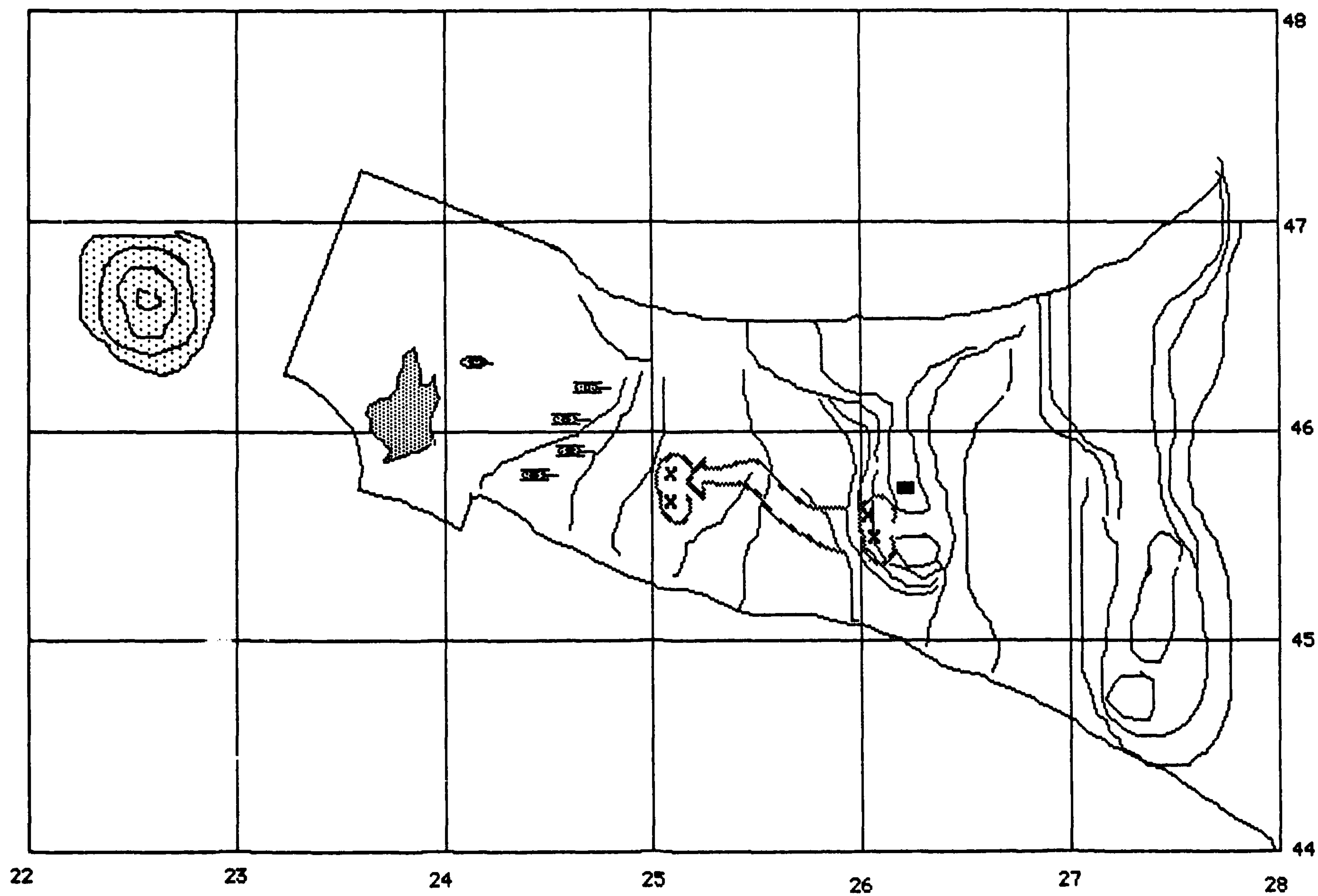


Figure G-13. Tank Table XII engagement seven.

NIGHT

ENGAGEMENT 8: DEFEND FROM A HASTY BATTLE POSITION

1. Platoon is in MOPP 3.

2. Platoon has occupied hasty BP.

3. Platoon is under Artillery fire.

4. Target Presentation and Array:

TGT	41	Tank (moving)	Range 1000-1200 m
TGT	43	Tank	
TGT	42	Tank (stationary)	Range 1200-1400 m
TGT	apd	Tank	
TGT	48	BDRM (ATGM)	Range 1200-1400 m
TGT	46	BDRM	

*Note BMP may be substituted @ ranges 800-1200 m and 1000-1200 m.

5. Engagement is conducted at night under illumination.

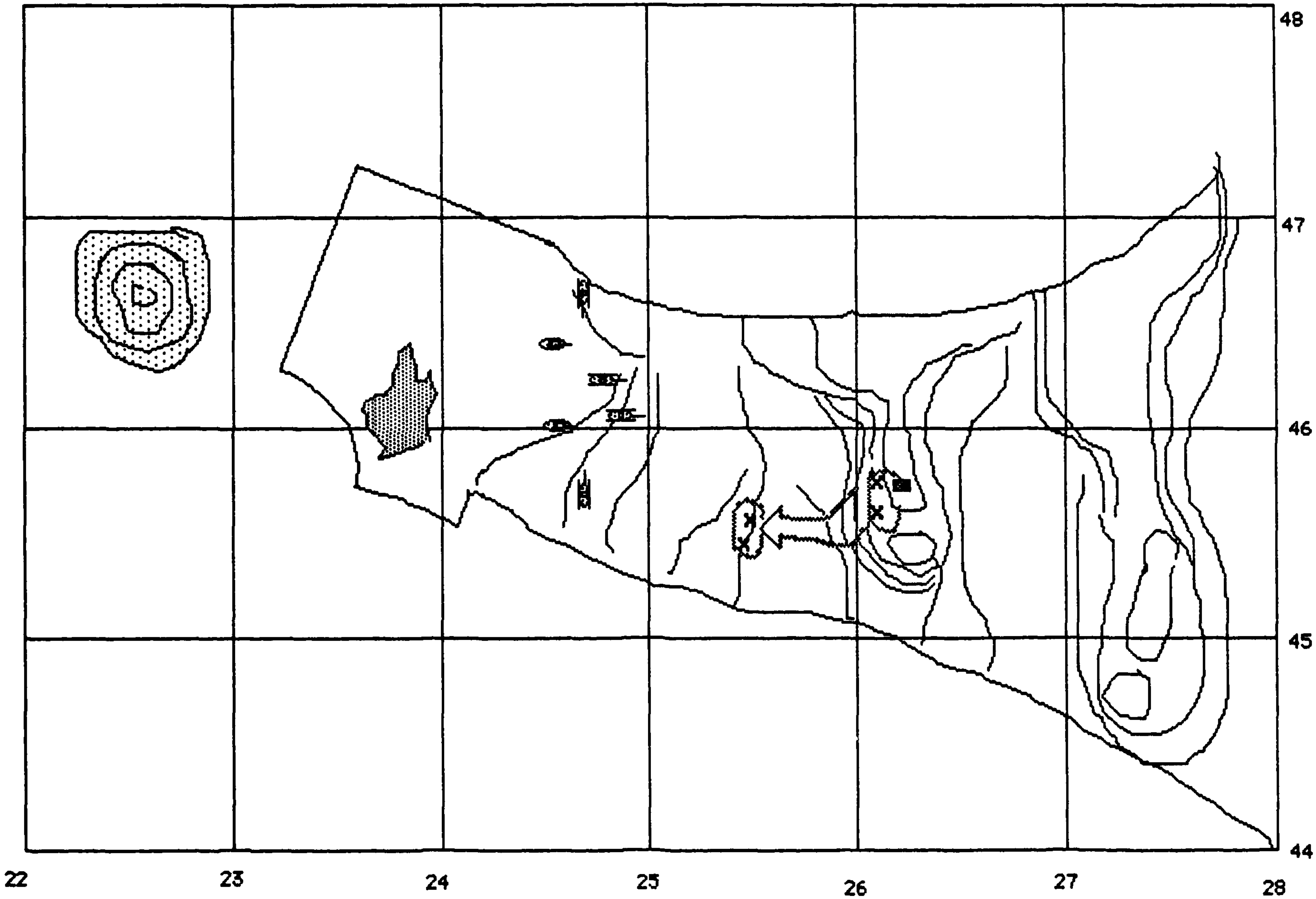


Figure G-14. Tank Table XII engagement eight.

<u>NIGHT</u>

ENGAGEMENT 9: PROVIDE OVERWATCH OVER SMOKE

1. Platoon is overwatching another platoon.

2. Platoon's position is masked by smoke.

3. Target Presentation and Array:

TGT	36	Tank (stationary)	Range 1200-1600 m
TGT	35	Tank	
TGT	34	Tank	
TGT	32	Tank	
TGT	apd	Tank (moving)	
TGT	31	Tank	
TGT	29	BDRM (ATGM)	Range 1400-1600 m

*Note BMP may be substituted @ ranges 900-1300 m.

4. Engagement is performed at night under indirect illumination.

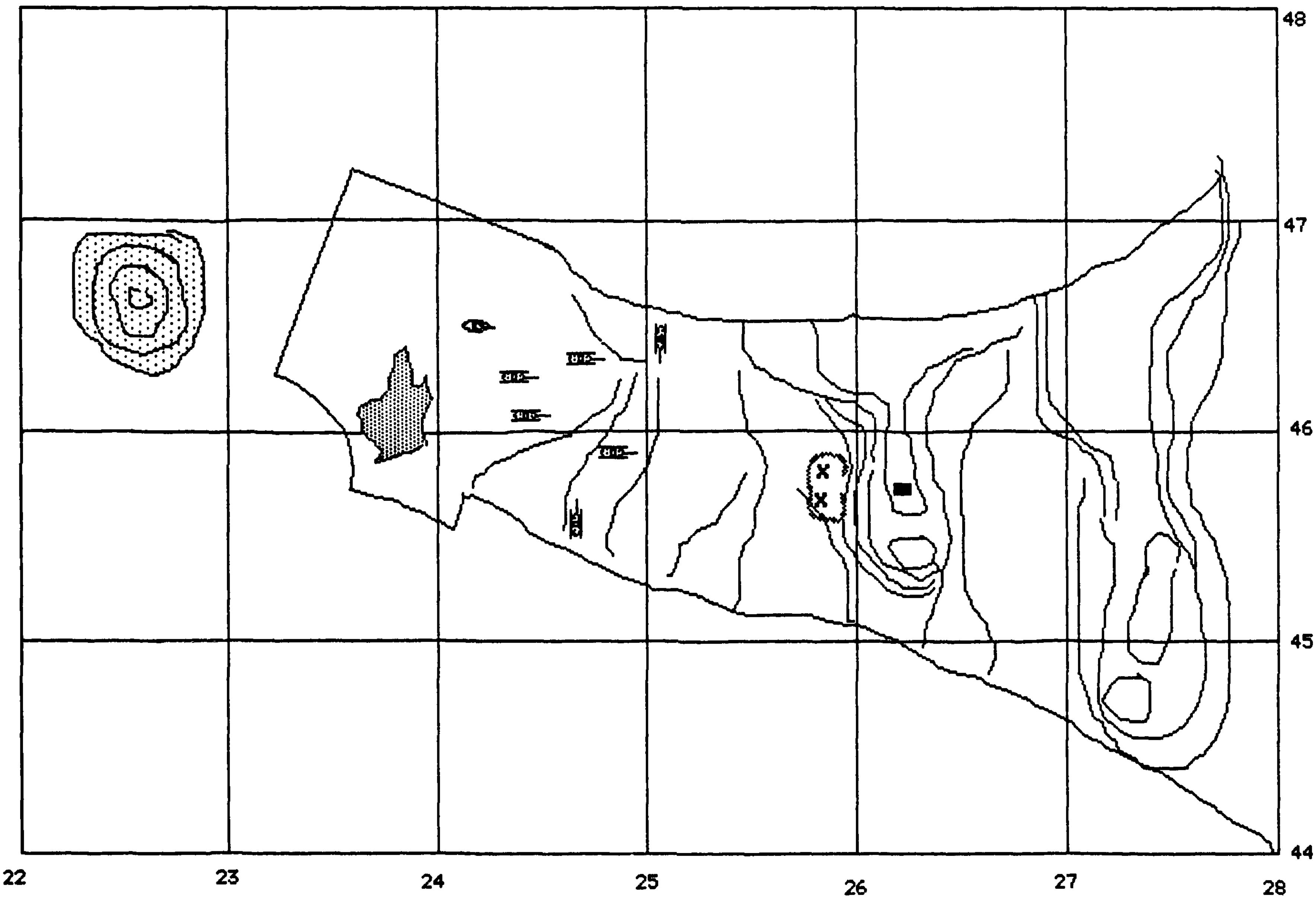


Figure G-15. Tank Table XII engagement nine.

NIGHT

ENGAGEMENT 10: CONDUCT MOVEMENT TO CONTACT

1. Platoon is in contact.

2. No overwatch is provided by another platoon.

3. Platoon must bound by section.

4. Target Presentation and Array:

TGT	22	Tank	Range 1000-1400 m
TGT	23	Tank	
TGT	21	Tank	
TGT	20	BDRM (ATGM)	Range 1400-1600 m
TGT	19	BDRM	

*Note BMP may be substituted @ range 1000-1200 m.

5. Engagement is conducted at night under indirect illumination.

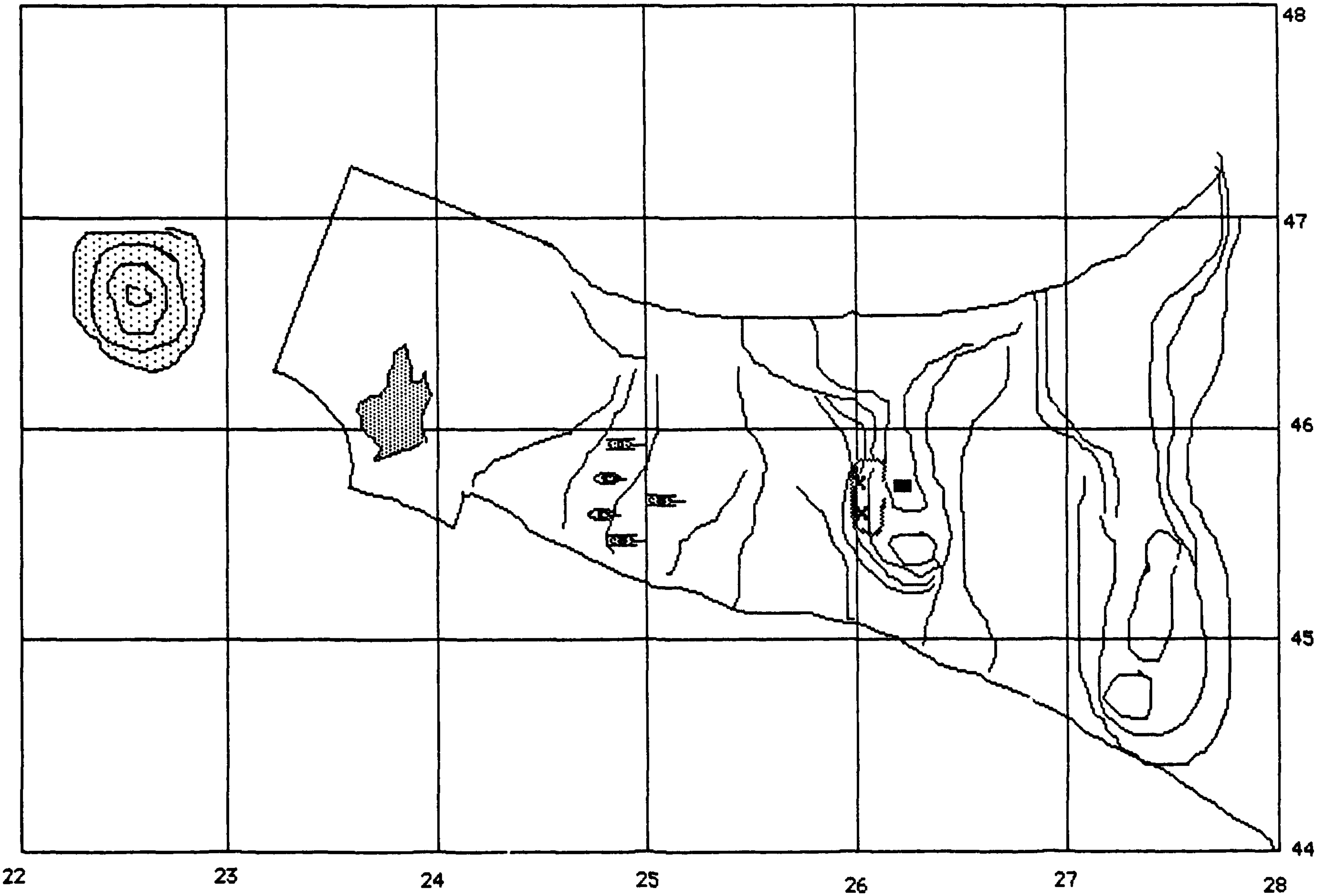


Figure G-16. Tank Table XII engagement ten.